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(6) Supersonic Transport Development Program

Phase III Proposal

BOEING MODEL 2707

Volume II-6-1

AIRFRAME DESIGN REPORT

PART A

WEIGHT AND BALANCE

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PREPARED BY E. M. Brown APPROVED BY [illegible signature]

(10) E. M. Brown

(15) [redacted] FA-SS-66-5

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THE BOEING COMPANY
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3

CONTENTS

B-2707 PHASE III PROPOSAL DOCUMENTATION INDEX

1.0 INTRODUCTION AND SUMMARY

1.1 Introduction. The Airframe Design Report is one of a series of documents under Vol. II, Technical/Airplane, called for by the FAA Request for Proposal for Phase III of the Supersonic Transport Development Program. The Airframe Design Report is bound into five documents, Component Design, Part B, V2 B2707 6 2; Structural Criteria, Loads, Flutter and Aerodynamic eating, Part C, V2-B2707-7; Materials and Processes, Part D, V2-B2707-8; Structural Test, Part E, V2-B2707-9; and this document, Weights and Balance, Part A, V2-B2707-6-1.

This report gives a detail weight breakdown of the proposed airplane and the design data and methods used in determining these weights. The report also includes moment of inertia, balance, and loading information. Supplement A provides weight data for the prototype airplane and Supplement B provides data for the domestic.

All data are presented in accordance with FAA Supersonic Weight and Balance Standard SST 65-13, September 1, 1965.

1.2 Summary. The design gross weight of the prototype has been selected to take advantage of the Company's experience with the growth of large jet aircraft. Historically, a large part of an airplane structure has strength capability higher than the design value. Local areas which have strengths below that of the majority of the structure are found and reinforced during intensive analytical, static, fatigue, and flight test programs. The B-2707 component test program has been scheduled to support these improvements for the first production airplanes. The improved strength capability has been realized in commercial and military service. When the deficient components are strengthened, increases in gross weight (and weight ratio) with accompanying improvement in payload-range results. The increase in payload range for two of the Boeing transport point design airplanes is shown in Fig. 1-1.

The gross weight for the B-2707 production airplane at certification, after test program development, is 675,000 lb. The gross weight for the B-2707 prototype point design airplane has been set at 635,000 lb. An increase in structures weight of 4,000 lb is conservatively forecast as required for the prototype structural growth to the production value.

The prototype has been chosen with the same geometry, fuel volume, and runway flotation capability as the first production airplane.

The B-2707 design weight is believed to be conservative. Data on growth of aircraft available at Boeing is used to substantiate an evaluation of the weights proposed for the B-2707 production airplane. Table 1-A summarizes some of the data.

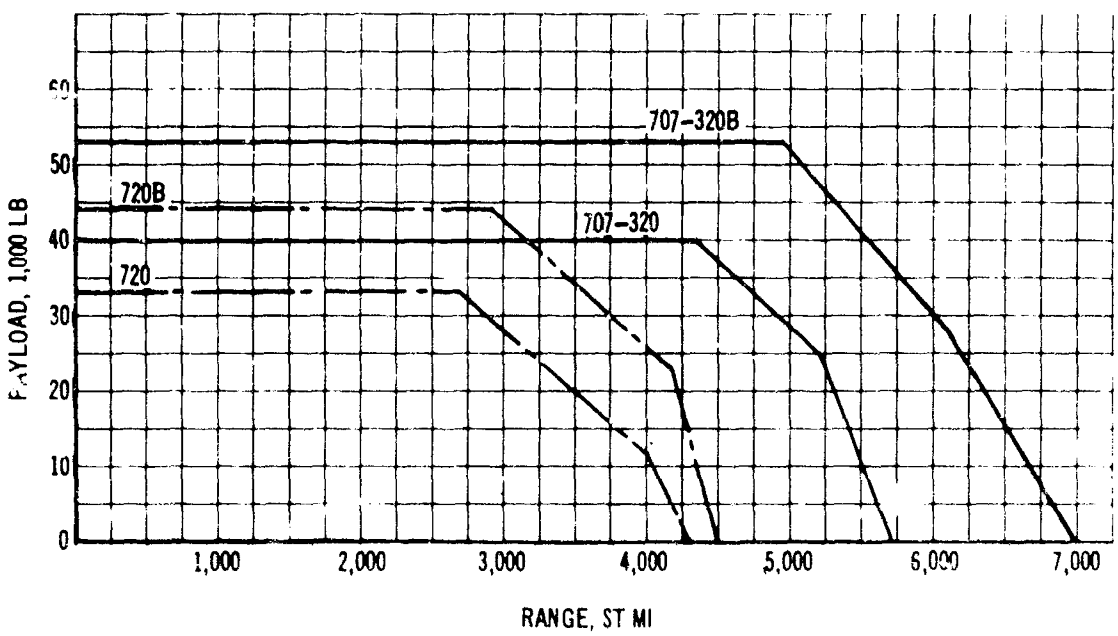


Figure 1-1. Performance Improvement

Table 1-A. Subsonic Airplane Growth

Model	Maximum Gross Weight lb		Structural Weight Increase, lb	Remarks
	Taxi	Flight		
707-320	296,000	296,000		First basic airplane
	302,000	296,000	Negligible	Loads refinement
	316,000	310,000	234	Gear and body increased strength, flight load survey KC-135
707-320B	328,000	326,000	2,700	Flaps, body, and main gear increase. Fan engine change not included in weight increase (-1,500 lb)
707-320C	336,000	331,600	560	Gear and wing reinforcement. Pressure model test. Improved analysis and higher effectiveness in root extensions.
Change	+40,000		+ 3,494	
XB-52	390,000	390,000		First basic airplane
RB-52C	450,000	450,000	520	Wing, body, and gear changed. Increase external tank size (1,300 lb in useful load)
B52-G	500,000	488,000	Zero	Wing upper surface. Integral stiffeners. Wing integral fuel tanks.
G-H Less Stress	500,000	488,000	7,200	Required because of change in usage. Increase aft body strength. Change wing lower surface to 24S alloy and upper surface to 75S. Fan engines not included.
Change	+ 110,000		+ 7,720	

It should be noted that the small relative increases in weight to increase the structural strength can be provided with insignificant effect on cost. A dollar-sign coordination concept has been established between Engineering and Manufacturing. It is a preplanned program for structural strength growth, either up or down, by establishing complete ground rules in the initial detail design period. Thus tooling, manufacturing, and engineering work for the life of the program to established surfaces that remain fixed. Growth is made by minor revisions to other surfaces. All tooling is preplanned to allow such variations. This concept has been in successful operation on all our commercial jet programs. The details of this program are outlined in Manufacturing Program, V5-B2707-9.

The weights contained herein are for the 277-passenger International Mixed arrangement.

The integrated wing and horizontal tail arrangement provides significant weight advantages. The wing and horizontal tail structural boxes have their depths determined by the wing aft chord length and thickness ratio, providing maximum box depth in both surfaces. The structural depths, wing fuel volume, and higher torsional and bending rigidity for flutter, together contribute to considerably lower weight compared to two individual surfaces. The average unit weight of the primary wing box structure is approximately 16.4 psf compared to 19.5 psf on the B-733-390, discussed in the Phase II-C Interim Report.

The engines are located aft on the horizontal tail and are protected from spray and hard objects by the wing flap system. (See System Engineering Report, V2-B2707-1, Par. 4.2.3.) There is no primary structure in the engine blast zone.

The aft engine location resulted in some compromises in balance and loading because of aft concentration of masses. However, the benefits provided by this concept are of such magnitude that the overall performance and operational characteristics are superior to other arrangements. The B-2707 balance and loading characteristics are similar to those encountered on current aft engine configurations. The loading and fuel management are relatively simple and will not result in unusual training or operational problems.

The wing is located to take advantage of the desirable features of the configuration by providing good balance and loading characteristics with maximum performance for the normal payloads. Ground stability is excellent with the four-landing-gear arrangement. The airplane may be fueled using normal fuel loading procedures with any wing sweep and the gear manifold locked out.

The methods used for weight estimation are analytical and use detail loads and allowable stresses for the complete operational envelope. Allowances are added for non-optimum design, and other items such as fittings, brackets, and supports. The structural methods have been proven on current subsonic airplanes and the correlation with detail stress analysis results is excellent.

Stress analysis results and detail component design are used when available to substantiate weight of major components. In the systems groups, available supplier proposals are used for component weights when reasonably substantiated.

The effects of dynamic load analysis and flutter clearance test results are included in the weights. See Airframe Design Report, V2-B2707-7. The body dynamic magnification factors for landing impact and gust are considered together with pressure and other flight and ground conditions in the structural weight analysis. No additional weight is required in the body to improve ride or flutter characteristics.

No additional weight is required for flutter over strength requirements in the wing, vertical tail, control systems, or panels. Additional stiffness of approximately 2,000 lb is included in the horizontal tail to increase control surface effectiveness with resulting increases in flutter margins. (See Airframe Design Report, V2-B2707-6-2.)

Adequate fatigue life is provided by the strength design for primary structure except joints and wing center section lower surface. The 1-g stress levels and fatigue analysis are discussed in V2-B2707-6-2. A weight addition of 160 lb was required to bring the fatigue life to the desired level.

The structure is not critical for sonic considerations. (See Airframe Design Report, V2-B2707-6-2.)

The primary structure is Ti 6Al-4V. Extensive use is made of polyimide fiber glass in secondary structure.

Allowances for state-of-the-art improvements are included in the weight estimates to reflect developments that will occur during the production phase.

Diffusion bonding is an alternate method of providing a skin stiffener design which can be more efficiently tailored to load requirements. A Phase I study was performed in conjunction with North American Aviation to explore the weight saving that can be realized by this method. Further development of this fabrication technique will provide a significant weight saving potential.

Processes such as electrochemical machining may be used to reduce tolerances and economically machine complicated parts, eliminating heavy, costly and complicated built-up sections (see Airframe Design Report, V2-B2707-8, Sec. 3.8).

An effective weight control program is currently in operation and will continue throughout both the prototype and production phases to ensure compliance with weight guarantees. Design decision processes are established to provide high-level management visibility and authority for weight reduction or weight change.

All inertia and balance data are derived for the 675,000-lb production airplane.

2.0 DIMENSIONAL AND STRUCTURAL DATA

The airplane general arrangements, with dimensions, are shown in Figs. 2-1 and 2-2. The inboard profiles for the airplanes are shown in Figs. 2-3 and 2-4. Table 2-A gives the dimensional and structural data.

Table 2-A. Dimensional and Structural Data

Length overall = 306 ft	Height overall, Static = 48.17 ft				
Tail Length, 60% Wing Reference Chord to 25% Mac of Exposed Horizontal Tail = 520.4 in.					
	Limit Load Factor	Design point 635,000 gross weight		Production 675,000 gross weight	
		GE	P&WA	GE	P&WA
Maximum Design Taxi Weight	1.67 Gear	635,000	635,000	675,000	675,000
	2.0 Other				
Maximum Design Takeoff Weight, flaps down	2.0	632,500	632,500	672,000	672,000
Maximum Design Flight Weight, flaps down	2.0	628,000	628,000	668,000	668,000
Maximum Design Flight Weight, flaps up	2.5	627,000	627,000	666,000	666,000
Maximum Design Landing Weight	2.0	425,000	415,000	430,000	420,000
Maximum Zero Fuel Weight		358,500	356,000	362,500	360,000
Minimum Flying Weight		310,000	306,000	314,000	310,000
Operational Empty Weight		283,500	281,000	287,500	285,000
Manufacturer's Empty Weight		272,750	270,250	276,750	274,250
Airframe Weight		214,027	214,227	217,737	217,927
277-passenger International Mixed payload (90-10 distribution)		55,400	55,400	55,400	55,400
Allowable payload		75,000	75,000	75,000	75,000
Landing approach speed @ maximum landing weight (kn)		152	150	153	151
Takeoff speed @ maximum takeoff weight (kn)		164	164	169	169

	Leading Edge	Wing	Horizontal tail		Vertical tail
			Total	Movable	
Basic Area (sq ft)	72 deg	5,830	—	—	—
Reference Area (sq ft)	72 deg	9,000	2,478***	422	875
Span (ft)	72 deg	105.74	93.37	30.87	23.15
	30 deg	174.28	—	—	—
Leading edge sweep angle (deg)	72 deg	30 to 72	60 & 55	60	60
Vertical tail reference chord @ WL 328-length (in.)		—	—	—	730.4
-maximum thickness (in.)		—	—	—	21.9
Wing reference chord @ BL 0-length (in.)		1,896.7	—	—	—
Theoretical chord @ BL 67.5-length (in.)		1,714.1	Incl.	—	—
-maximum thickness (in.)		48.85	—	—	—
Theoretical chord @ Pivot-length (in.)		1,393.6	Incl.	—	—
-maximum thickness (in.)		39.72	—	—	—
Theoretical chord @ BL 375-length (in.)		882.4	Incl.	—	—
-maximum thickness (in.)		24.71	—	—	—
-length (in.)		565.17	—	305.2	—
-maximum thickness (in.)		24.71	—	9.16	—
Theoretical tip chord-length (in.)		200.1	70.0	—	173.8
-maximum thickness (in.)		6.00	2.10	—	5.22

Table 2–A Dimensional and Structural Data (Continued)

Hydraulic System Capacity (Gal) = 152.5

Fuel Capacity (gal)	Tanks	Capacity
Wing	2	15,060
Horizontal tail (including center section)	2	8,300
Body, strake and wing center section	4	32,570

Oil Capacity (gal)	Capacity
Engine lubrication and hydraulics	19.5
Accessory drive gear box and accessory lubrication	22.0

	Nacelles (ea)		Fuselage
	GE	P&WA	
Length, Maximum (ft)	37.3	28.9	300.0*
Depth, Maximum (ft)	7.33	7.33	14.8
Width, Maximum (ft)	7.33	7.33	13.7
Wetted Area (sq ft)	675	575	9,865
Pressurized body volume (cu ft)			18,306
Total body volume (cu ft)			24,476
Ultimate design pressure (psi) (2.5 factors)			27.8

Areas (Sq Ft)	
Ventral	201
Dorsal	0
Wing	
Flaps-Inboard **	210
-Outboard **	684
Slats-Inboard	420
-Outboard	393
Spoilers	236
Ailerons	120
Horizontal Tail	
Elevons	422
Elevators-Inboard Auxiliary	149
-Primary	211
-Outboard Auxiliary	111
Vertical Tail	
Rudder	287

Landing Gear	Forward Main	Aft Main	Nose
Length, oleo extended ℄ aft axle to ℄ trunnion (in.)	165	165	116
Oleo Travel, oleo extended to static position (in.)	16	45	13
Tires-Numbers	8	8	2
-Size	45 x 19.2	45 x 19.2	34 x 16
-Type	VIII	VIII	VIII

* Body Station Reference - Nose @ BS 200

** See Table 7-B For Details

*** Included in Wing Area

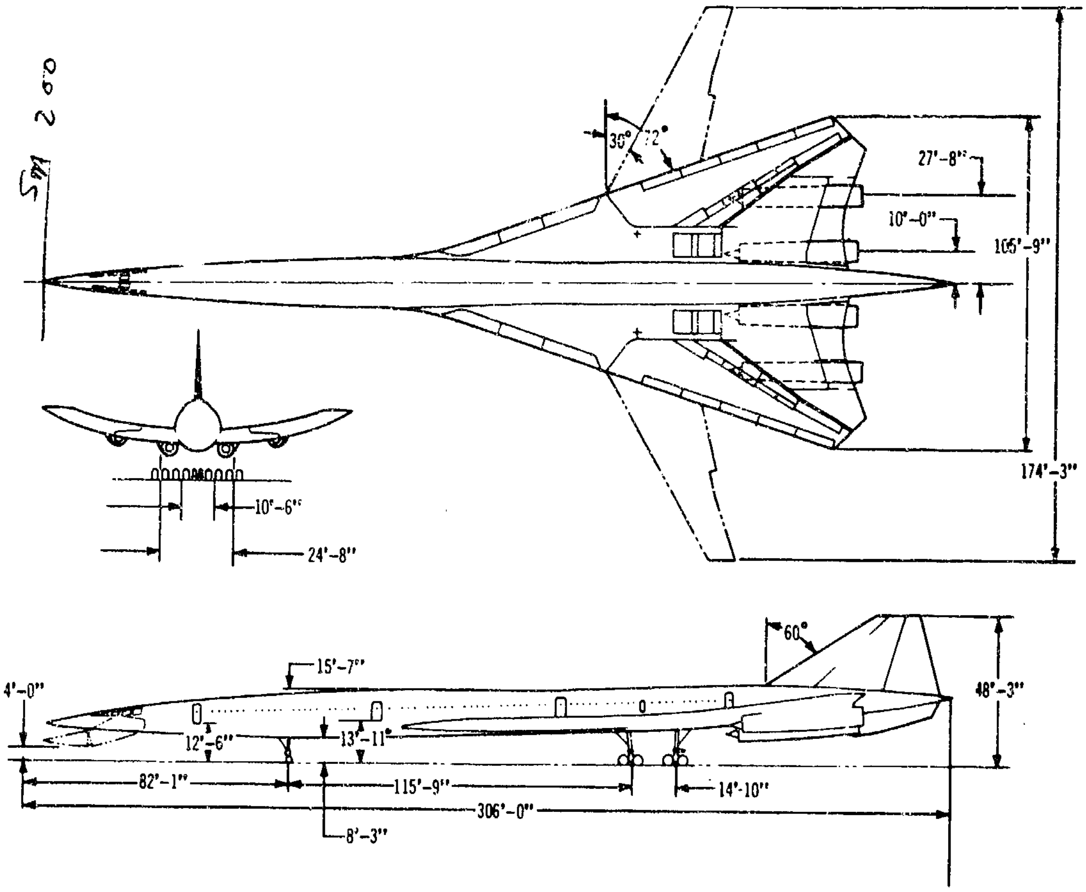


Figure 2-1. General Arrangement Drawing, B-2707 (GE)

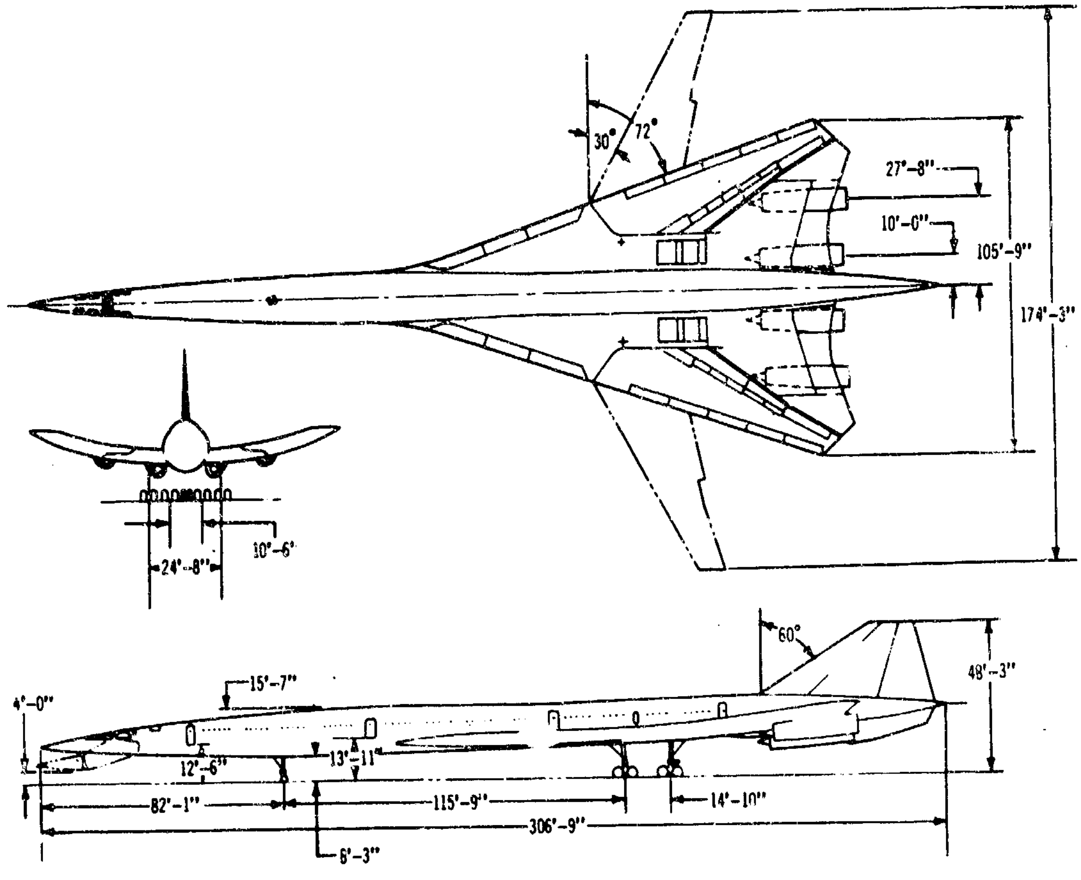
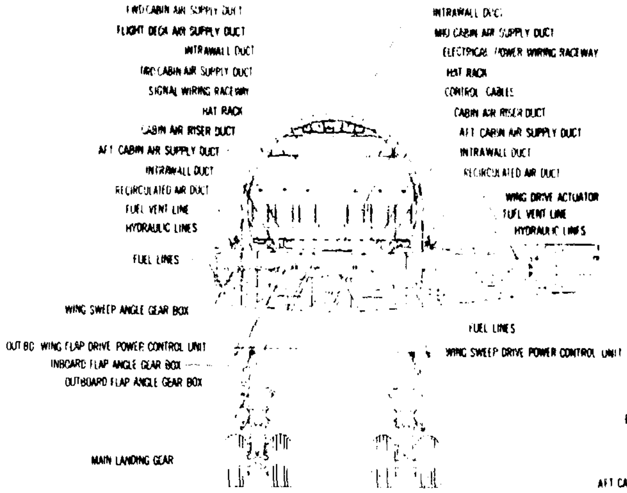
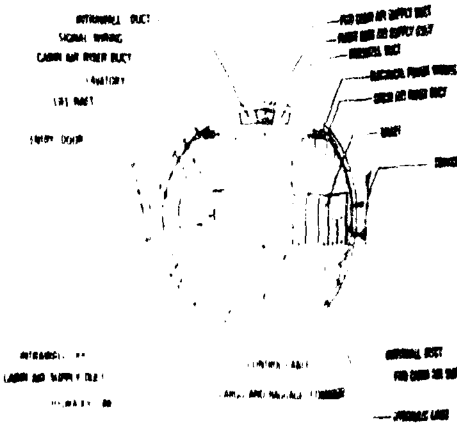


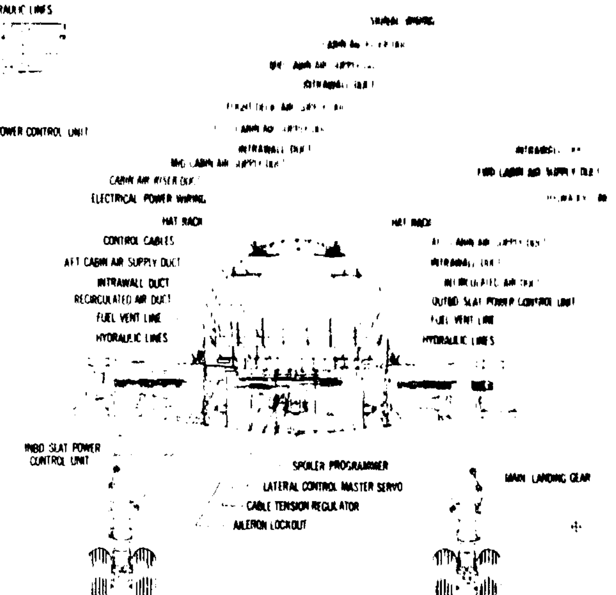
Figure 2-2. General Arrangement Drawing, B-2707 (P&WA)



SECTION E-E

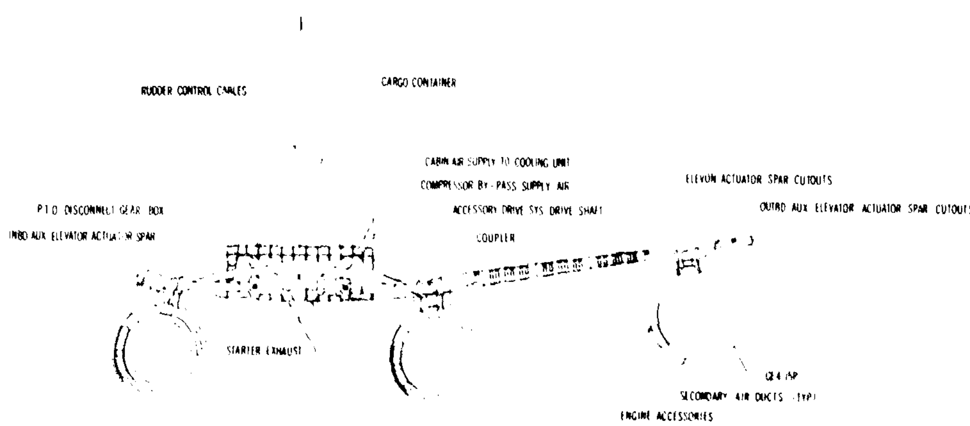


SECTION C-C

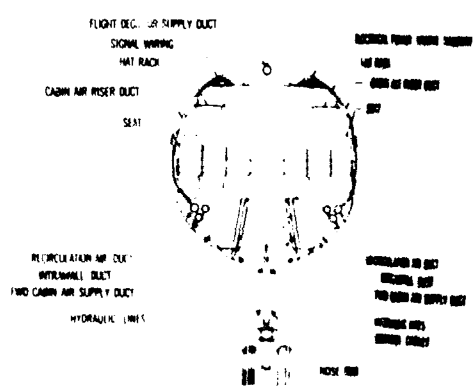


SECTION D-D

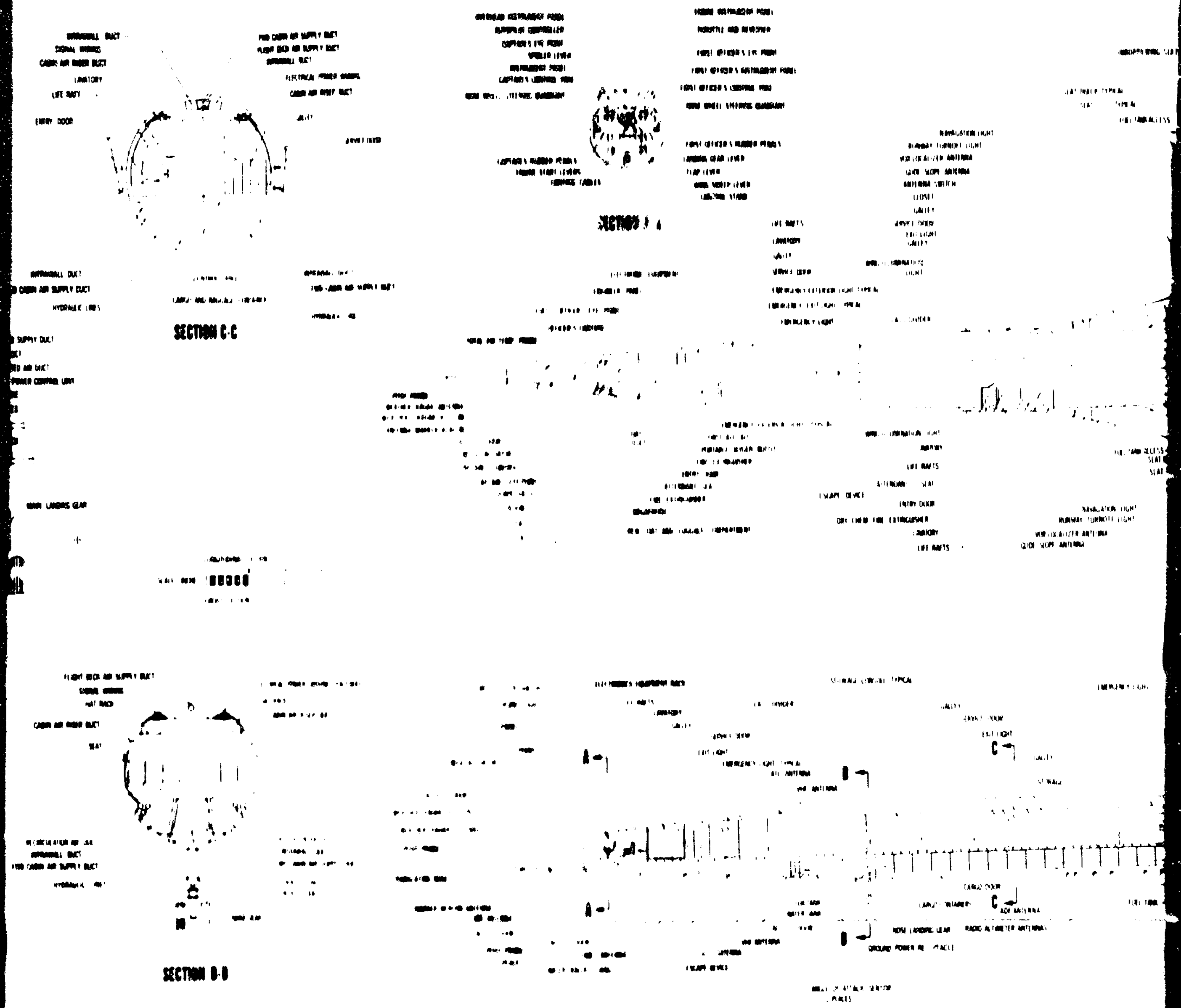
LONGITUDINAL SCALE (INCHES) CROSS SECTION



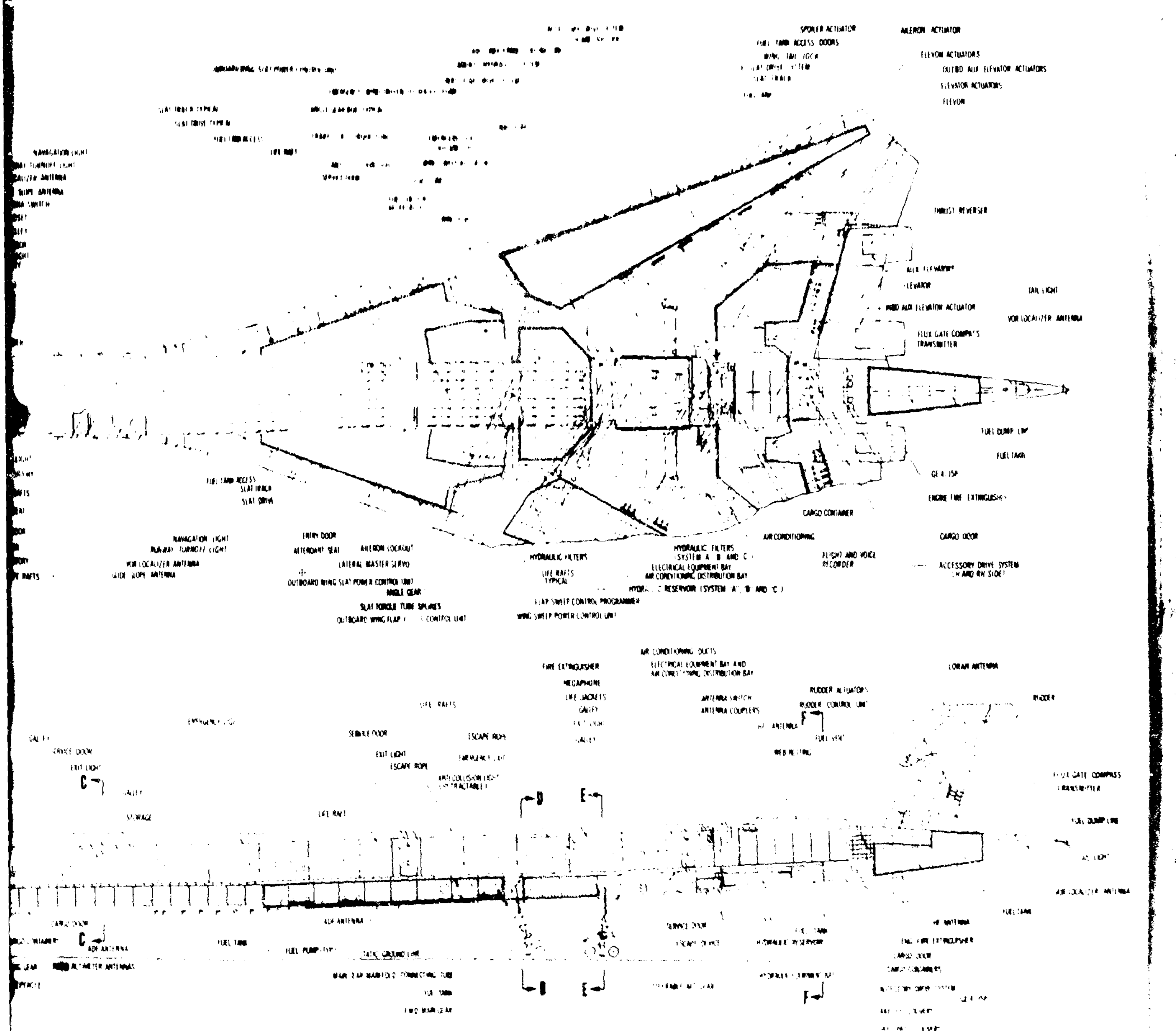
SECTION F-F



SECTION B-B

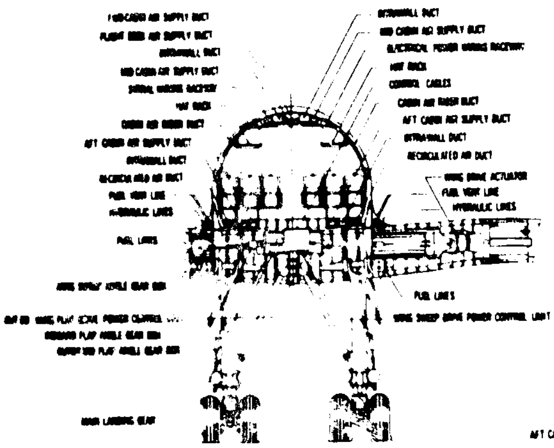


SECTION C-C
SECTION D-D
MAIN LANDING GEAR
ENTRY DOOR
LIFE RAFTS
LAVATORY
GALLEY
NAVIGATION LIGHT
RUNWAY TURNOFF LIGHT
GLIDE SLOPE ANTENNA
CARGO DOOR
NOSE LANDING GEAR
RADIO ALTIMETER ANTENNA

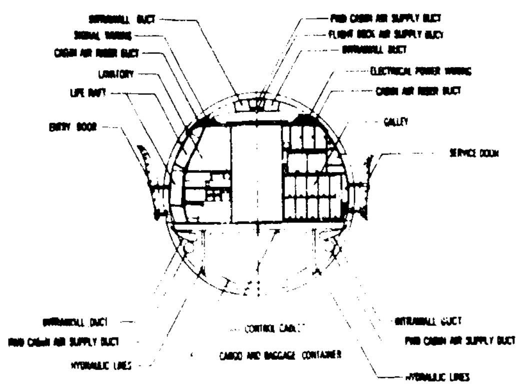


C

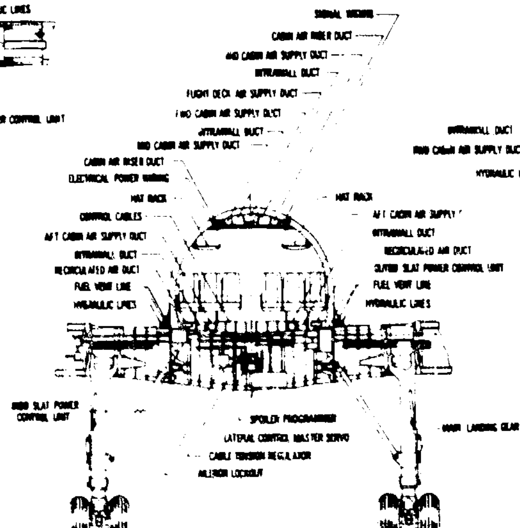
Figure 2-3. Inboard Profile Drawing, B-2707 (GE)



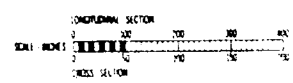
SECTION E-E

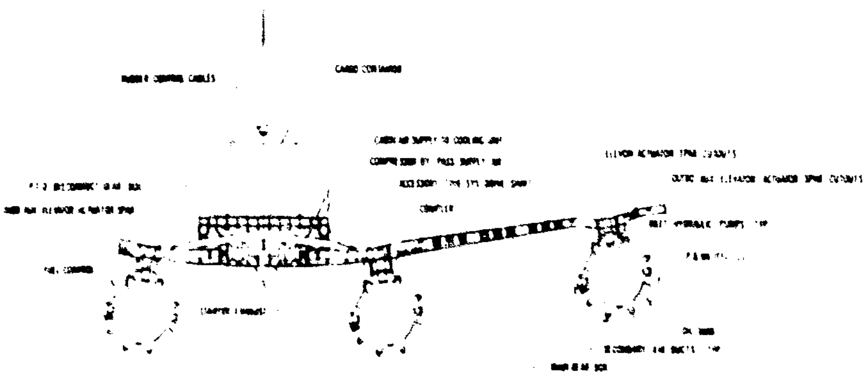


SECTION C-C

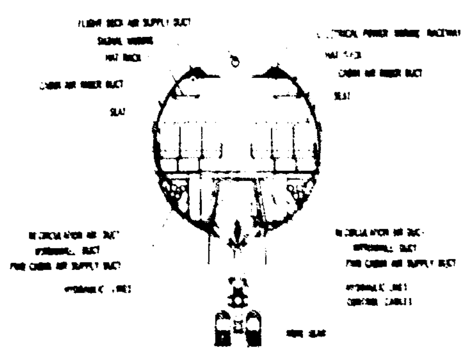


SECTION D-D





SECTION F-F



SECTION B-B

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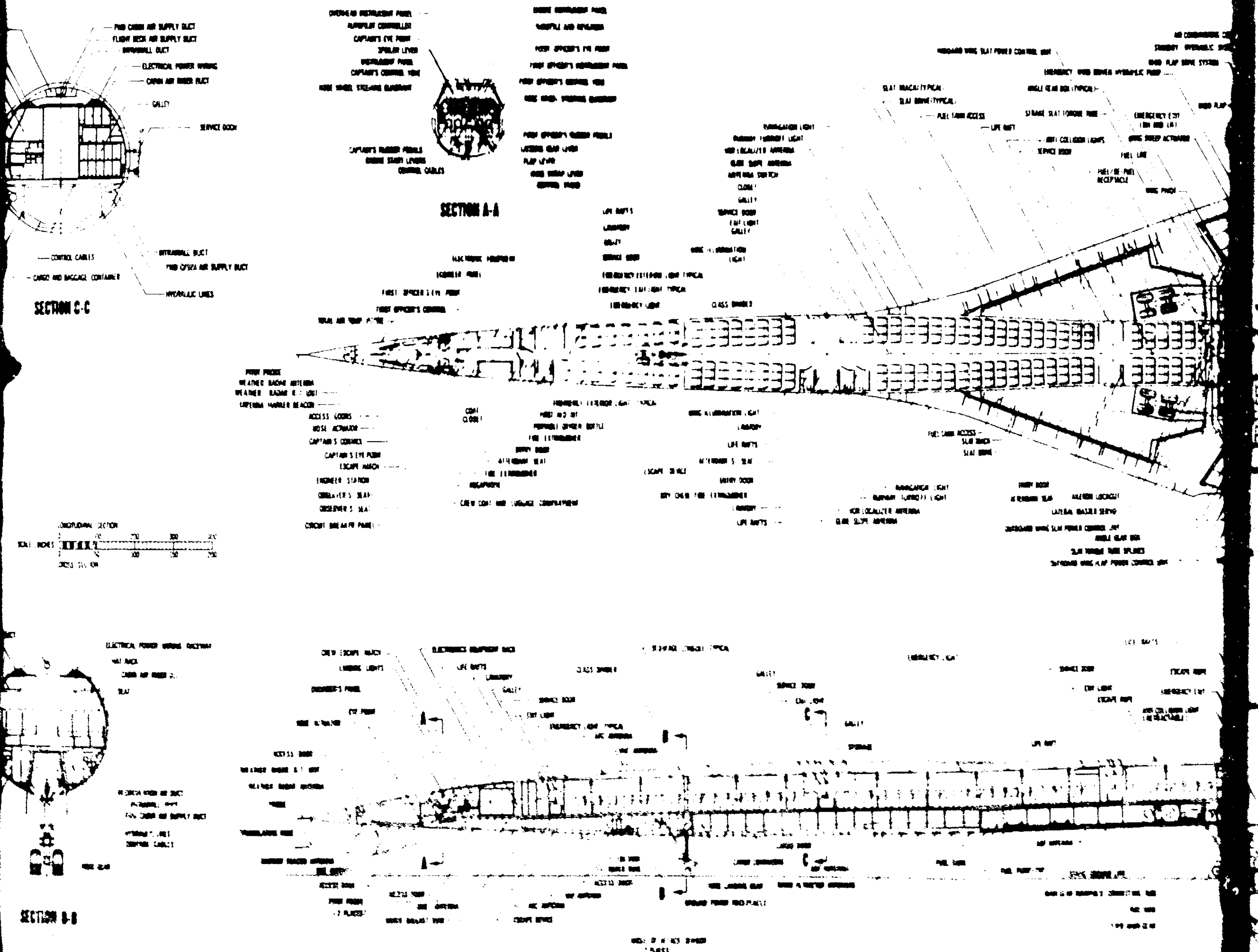

SECTION A-A
SECTION C-C
SECTION B-B
GALLEY
SERVICE DOOR
CONTROL CABLES
CARGO AND BAGGAGE CONTAINER
HYDRAULIC LINES
FIRST OFFICER'S EYE POINT
LIFE RAFTS
CLASS DIVIDER

B

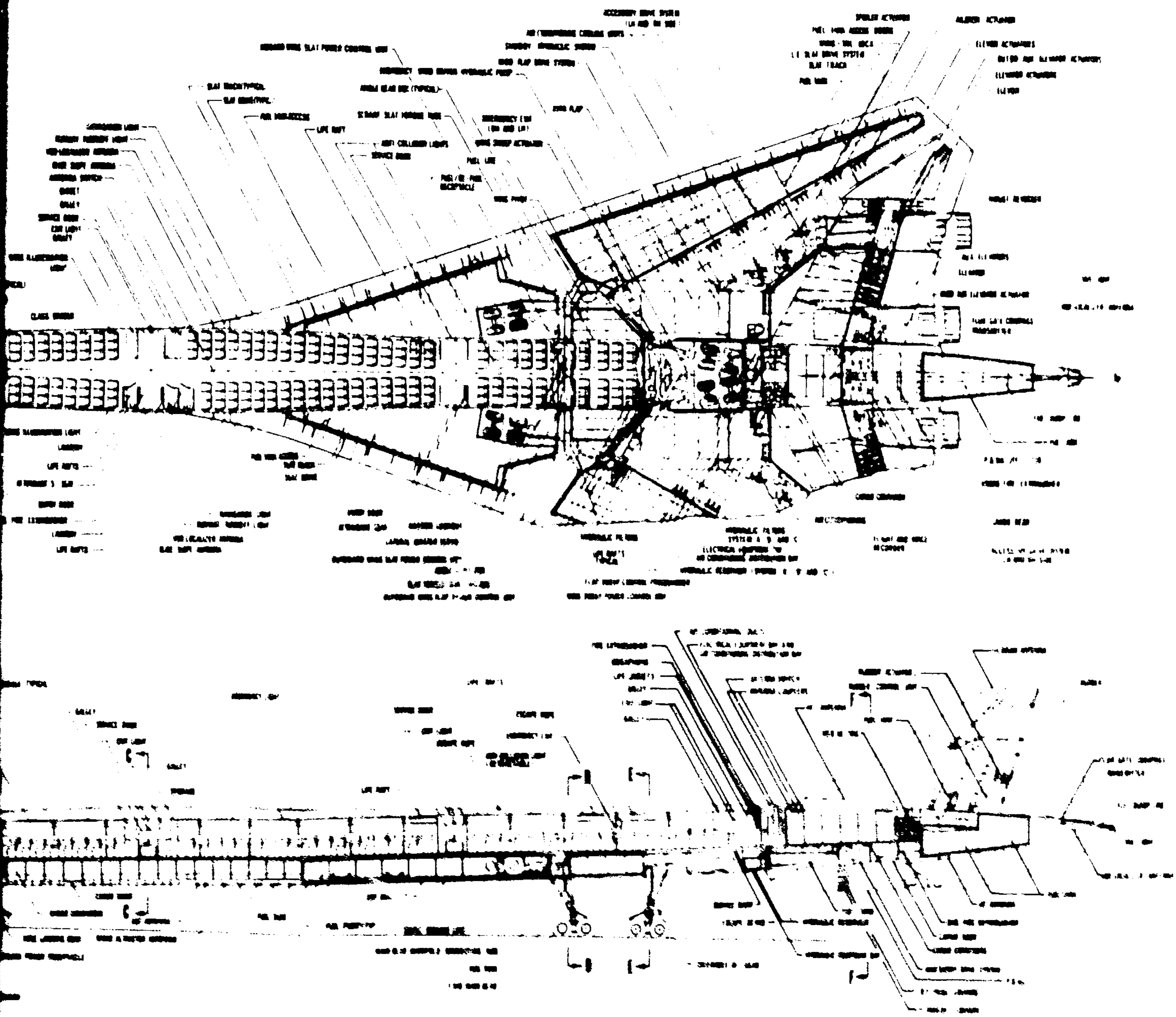


Figure 2-4. Inboard Profile Drawing, B-2707 (P&WA)

3.0 GROUP WEIGHT STATEMENT

A group weight breakdown of the 635,000-lb gross weight design point airplane is given in Table 3-A along with incremental weight changes to grow the airplane to 675,000-lb gross weight for the production version. Table 3-B provides a group weight statement for the 675,000-lb production airplane with horizontal and vertical moment arms.

Table 3-A. Group Weight Statement, Design Point Airplane

	GE	P&WA
Wing	[illegible],900	63,900
Horizontal tail	20,300	20,460
Vertical tail	5,000	5,000
Ventral tail	550	550
Body	47,100	47,020
Main landing gear	25,500	25,500
Nose gear	1,500	1,500
Nacelle	12,300	12,900
Total Structure	(176,150)	(176,830)
Engine	44,500	[illegible]1,800
Engine accessories	1,100	1,160
Engine controls	300	300
Starting system	400	430
Fuel system	7,000	7,010
Total Propulsion Group	(53,[illegible])	(50,700)
Instruments	1,250	1,250
Surface controls	10,600	10,150
Hydraulics	3,[illegible]00	3,420
Electrical	3,600	3,600
Electronics	2,320	2,320
Furnishings	13,300	13,300
Air conditioning	5,500	5,500
Anti-icing and anti-fogging	280	330
Insulation	2,700	2,700
Ballast system	150	150
Total Fixed Equipment	(43,300)	(42,720)

Table 3-A. Group Weight Statement, Design Point Airplane (Cont)

	GE	P&WA
Manufacturer's Empty Weight	272,750	270,250
Unusable fuel	1,192	1,192
Unusable oil	252	252
Emergency equipment	512	512
Unusable water, wash and drink	10	10
Toilet water and chemical	150	150
Galley structure	2,049	2,049
Total Standard Items	(4,165)	(4,165)
Basic Empty Weight	276,915	274,415
Crew and crew baggage	1,850	1,850
Usable oil	80	80
Emergency equipment	1,975	1,975
Usable water, wash and drink	384	384
Passenger service equipment	720	720
Food and beverage	432	432
Galley service	639	639
Liquor service	393	393
Lavatory supplies	57	57
Plug-in type food trays	55	55
Total Operational Items	(6,585)	(6,585)
Operational Empty Weight (635,000 lb Maximum Design Taxi Weight)	283,500	281,000
Airplane Growth		
Wing	+2,200	+2,200
Body	+ 200	+ 200
Main landing gear	+ 800	+ 800
Nose gear	+ 20	+ 20
Fuel system	+ 500	+ 500
Surface controls	+ 280	+ 280
Total Operational Empty Weight Increase	(+4,000)	(+4,000)
Operational Empty Weight (Maximum Design Taxi Weight 675,000 lb)	287,500	285,000

Table 3-8. Group Weight Statement, Production Airplane

Group	B-2707(GE)			B-2707(P&WA)		
	Weight (lb)	Arms at Λ = 30°		Weight (lb)	Arms at Λ = 30°	
		Body Station	Waterline		Body Station	Waterline
Wing	66,100	2,524	215	66,100	2,524	215
Horizontal tail	20,300	3,230	240	20,460	3,230	240
Vertical tail	5,000	3,575	410	5,000	3,575	410
Ventral tail	550	3,580	205	550	3,580	205
Body	47,300	2,250	230	47,220	2,250	230
Main landing gear	26,300	2,665	90	26,300	2,665	90
Nose gear	1,520	1,180	100	1,520	1,180	100
Nacelle	12,300	3,163	180	12,900	3,259	185
Total Structure	(179,370)	(2,654)	(205)	(180,050)	(2,663)	(206)
Engine	44,500	3,312	190	41,800	3,371	195
Engine accessories	1,100	3,193	225	1,160	3,200	225
Engine controls	300	2,121	215	300	2,126	215
Starting system	400	3,120	200	430	3,140	200
Fuel system	7,500	2,721	210	7,510	2,721	210
Total Propulsion Group	(53,800)	(3,219)	(194)	(51,200)	(3,263)	(198)
Instruments	1,250	1,663	230	1,250	1,662	230
Surface controls	10,880	2,851	215	10,430	2,832	215
Hydraulics	3,600	2,890	210	3,420	2,884	210
Electrical	3,600	2,078	240	3,600	2,078	240
Electronics	2,320	1,024	230	2,320	1,024	230
Furnishings	13,300	1,883	250	13,300	1,883	250
Air conditioning	5,500	2,643	235	5,500	2,643	235
Anti-icing and antifogging	280	2,670	200	330	2,795	200
Insulation	2,700	1,911	265	2,700	1,911	265
Ballast system	150	867	180	150	867	180
Total Fixed Equipment	(43,580)	(2,271)	(234)	(43,000)	(2,259)	(234)
Manufacturer's Empty Weight	276,750	2,704	208	274,250	2,712	209
Unusable fuel	1,192	2,755	185	1,192	2,755	185
Unusable oil	252	3,175	210	252	3,199	210
Emergency equipment	512	1,910	235	512	1,910	235
Unusable water, wash and drink	10	990	170	10	990	170
Toilet water and chemical	150	1,901	235	150	1,901	235
Galley structure	2,049	1,962	260	2,049	1,962	260
Total Standard Items	(4,165)	(2,251)	(231)	(4,165)	(2,253)	(231)
Basic Empty Weight	280,915	2,697	208	278,415	2,675	209
Crew and crew baggage	1,850	1,344	240	1,850	1,344	240
Usable oil	80	3,246	195	80	3,325	195
Emergency equipment	1,975	1,910	235	1,975	1,910	235
Usable water, wash and drink	384	990	170	384	990	170
Passenger service equipment	720	1,947	260	720	1,947	260
Food and beverage	432	1,962	260	432	1,962	260
Galley service	639	1,962	260	639	1,962	260
Liquor service	393	1,962	260	393	1,962	260
Lavatory supplies	57	1,901	240	57	1,901	240
Plug-in type food trays	55	1,947	245	55	1,947	245
Total Operational Items	(6,585)	(1,729)	(241)	(6,585)	(1,730)	(241)
Operational Empty Weight	287,500	2,675	209	285,000	2,682	210

(Maximum Design Taxi Weight 675,000)

4.0 AIRFRAME WEIGHT AND MATERIALS BREAKDOWN

The airframe weight for the B-2707 is derived as follows:

	Design Point 635,000 lb gross weight		Production 675,000 lb gross weight	
	GE	P&WA	GE	P&WA
Manufacturer's Empty Weight	272,750	270,250	276,750	274,250
Delete				
Total	(-58,723)	(-56,023)	(-59,023)	(-56,323)
Wheels, brakes, tires and air	-8,352	-8,352	-8,652	-8,652
Engines, as supplied by the manufacturer	-44,500	-41,800	-44,500	-41,800
Accessory gear box drive	-566	-566	-566	-566
Engine starters	-204	-204	-204	-204
Fuel bladder cells	-321	-321	-321	-321
Instruments-indicators, transmitters, and amplifiers	-538	-538	-538	-538
Electrical-power supply, conversion equipment, and batteries	-1,110	-1,110	-1,110	-1,110
Electronic-electronic sets less wiring, connectors, racks, and radome	-1,142	-1,142	-1,142	-1,142
Air Conditioning-pressurization cooling, heat exchanger units, and fluid	-1.990	-1,990	-1,990	-1,990
Airframe Weight	214,027	214,227	217,727	217,927

The airframe weight is made up of the following materials:

	Design Point 635,000 lb gross weight		Production 675,000 lb gross weight	
	GE	P&WA	GE	P&WA
Structure	(167,798)	(168,478)	(170,718)	(171,398)
Titanium	128,900	129,400	131,400	131,900
Aluminum	2,100	2,100	2,100	2,100
Steel	17,200	17,300	17,500	17,600
Fiberglass	5,800	5,800	5,800	5,800
Glass	835	835	835	835
Fluid	875	900	875	900
Miscellaneous*	12,088	12,143	12,208	12,263
Nonstructure	(46,229)	(45,749)	(47,009)	(46,529)
Total Airframe Weight	214,027	214,227	217,727	217,927

*Miscellaneous includes such items as seals, fasteners, actuators, controls, hydraulics, etc.

5.0 BALANCE AND LOADING

The balance and loading characteristics of the production airplane are typical of airplanes with aft-mounted engines. The significant features are summarized below:

a. The relationship between the operational empty weight (OEW) center of gravity and the aft limits is such that the total airplane performance is optimized for payloads of 130 passengers or more.

b. For lower payloads, selected seating and/or ballast is required. A water ballast tank is located in a pressurized area forward of the nose gear to provide rapid flexible center-of-gravity (cg) control for low payloads.

c. The large cargo capacity in both the forward and aft compartments provide good loading flexibility and cg control. The forward cargo compartment is sufficiently large so that the cg may be brought within limits by loading forward cargo alone.

d. A single fuel loading procedure will maintain the airplane cg within acceptable limits, with no prior knowledge of the payload required other than the fact that the zero fuel weight cg must fall within the landing limits.

e. When the payload distribution is known, rapid transfer of fuel between the forward and aft auxiliary fuel tanks may be performed at the operator's option if it is desired to optimize the airplane cg for cruise performance.

f. A simple fuel management is used for all flights, using auxiliary tank fuel until depleted and then main tank fuel for the remainder of the flight. No inflight transfer of fuel is required to remain within flight cg limits.

5.1 Airplane Balance Data. The group weight s for the two production airplanes, with horizontal and vertical moment arms, are shown in Table 3-B. The essential balance data are summarized in Table 5-A. The cg limits are shown in Fig. 5-1.

5.2 Fuel Management. The fuel tank arrangement is shown in Fig. 5-2. The arrangement was selected for simplicity and reliability of operation while providing good cg control.

5.2.1 Fuel Loading. A standard fuel loading schedule is followed for any flight, with the distribution being a function only of the total fuel load required for the mission. Figure 5-3 indicates the quantity of fuel to be loaded in each tank for varying fuel loads.

When the payload distribution is known, it may be desirable to optimize cruise performance by transferring fuel from the forward auxiliary to the aft auxiliary tank. Fuel transfer is subject to the following limitations:

Table 5-A. Airplane Balance Data

General		
Leading edge of wing reference chord		Body Station 1440
Length of wing reference chord (C_R)		1,896.73 in.
Operational empty weight center of gravity		
GE		Body Station 2675 65.1% C_R
P&W		Body Station 2682 65.5% C_R
Capacities and Centroids		Body Station
Passengers, First Class	30	1021
Passengers, Tourist	247	2079
Aft cargo compartment	1,204 cu ft	3225
Forward cargo compartment	1,902 cu ft	1559
Fuel Tank No. 1	4,150 gal	3116
Fuel Tank No. 2	4,150 gal	1998
Fuel Tank No. 3	4,150 gal	2122
Fuel Tank No. 4	4,150 gal	3116
Forward auxiliary fuel tank	20,450 gal	2438
Aft auxiliary fuel tank	3,820 gal	3502
Outboard auxiliary fuel tanks 1A and 4A	15,060 gal	
Wing leading edge = 30 deg		2692
42 deg		2753
72 deg		2868
Water ballast tank	1,380 gal	867
Moment Changes		
Sweep empty wing from 30 to 72 deg	7,580,000 in.-lb	
Sweep empty wing from 30 to 42 deg	2,600,000 in.-lb	
Raise landing gear	139,000 in.-lb	
Leading edge slat retraction	82,335 in.-lb	
Trailing edge flap retraction	-200,760 in.-lb	

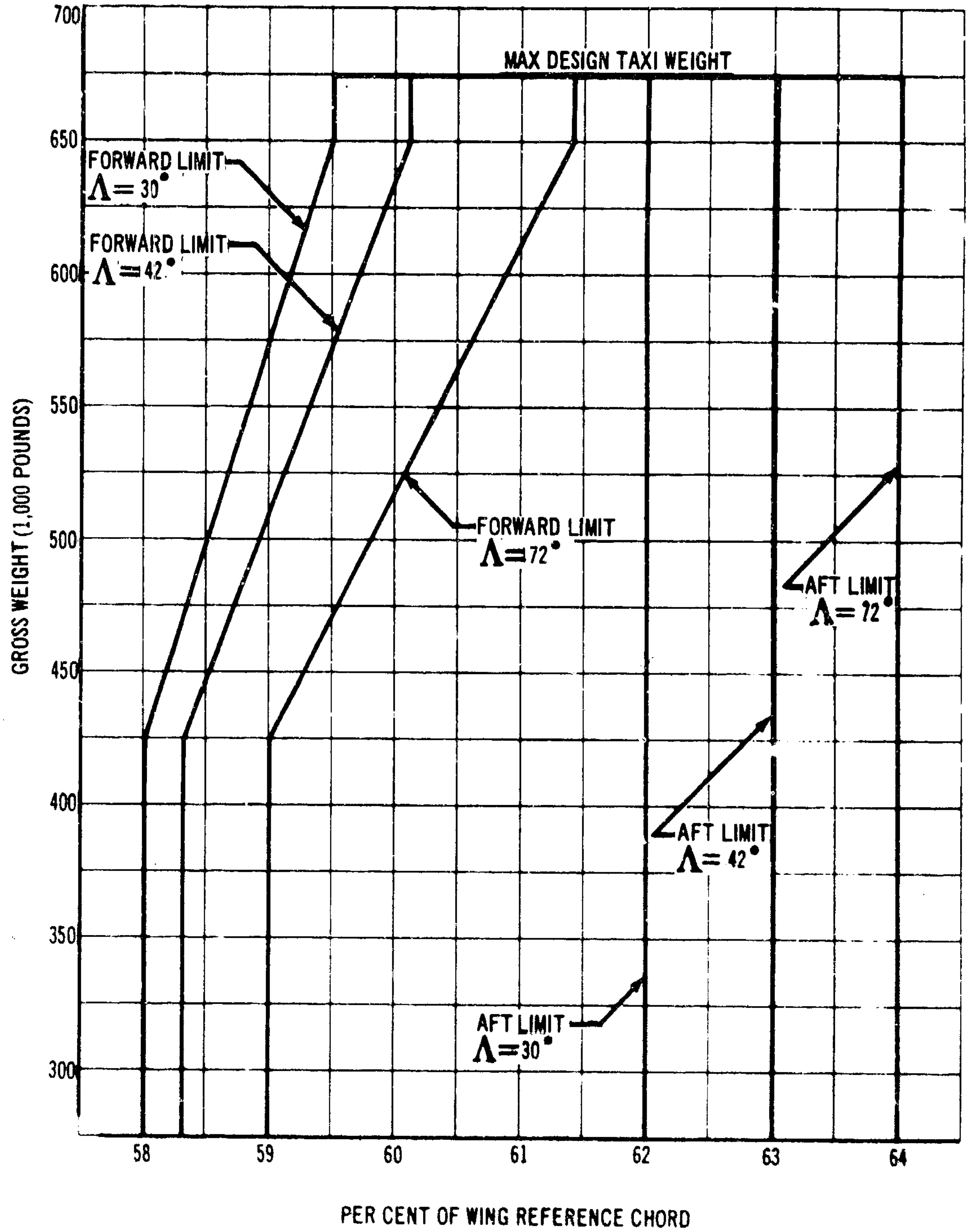
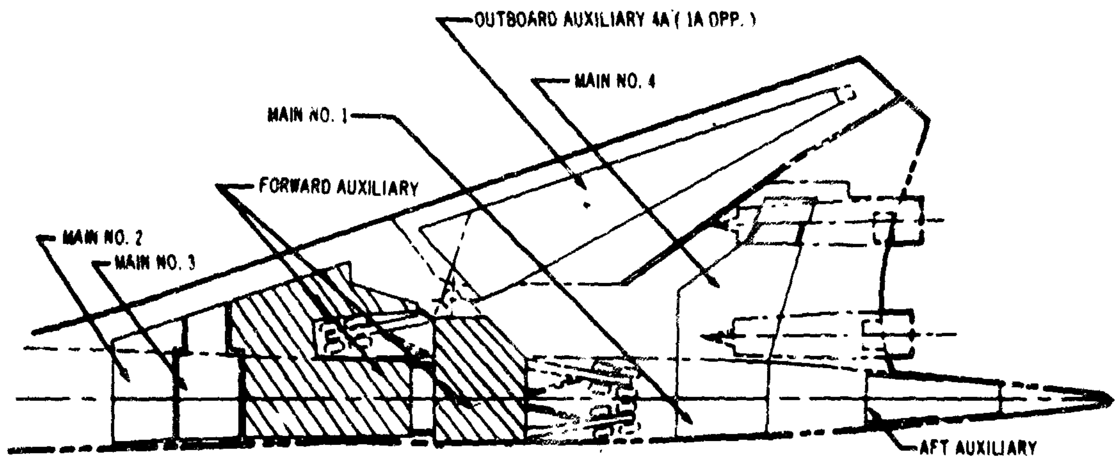


Figure 5-1. Operational Center-of-Gravity Flight Limits



TANK	FUEL GAL	FUEL LB
MAIN NO. 1	4,150	27,800
MAIN NO. 2	4,150	27,800
MAIN NO. 3	4,150	27,800
MAIN NO. 4	4,150	27,800
FORWARD AUXILIARY	20,450	137,000
AFT AUXILIARY	3,820	25,600
OUTBOARD AUXILIARY 1A	7,530	50,650
OUTBOARD AUXILIARY 4A	7,530	50,650
TOTAL CAPACITY	55,930	374,700

THE EXCESS VOLUME IN THE AFT AUXILIARY IS USABLE AT THE OPERATOR'S OPTION TO OPTIMIZE CRUISE CENTER OF GRAVITY FOR HIGH PAYLOADS

NOTE: MAXIMUM USABLE FUEL = 367,100 LB

Figure 5-2. Fuel Tank Arrangement

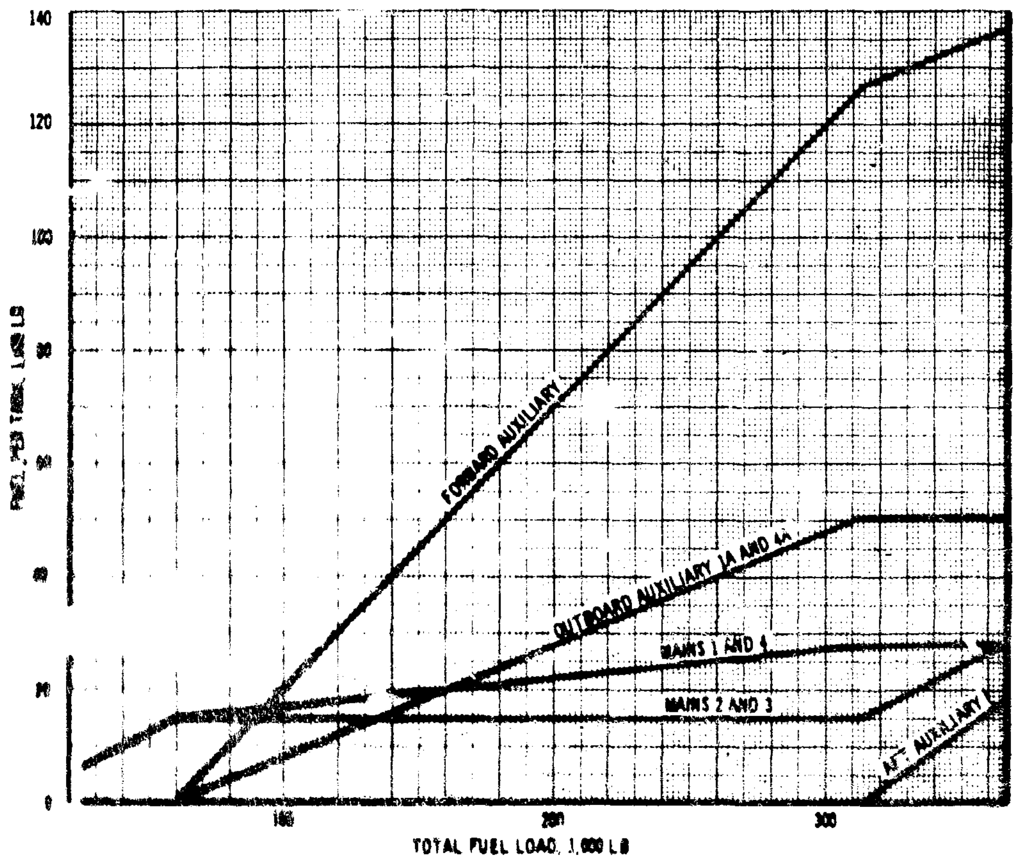


Figure 5-2. Fuel Loading

a. The quantity of fuel remaining in the forward auxiliary tank after transfer must equal or exceed the total fuel quantity in the outboard wing auxiliary tanks 1A and 4A.

b. The cg of the airplane after such transfer (assuming all transfer to be completed before takeoff) shall not exceed 61.6 percent of the wing reference chord.

5.2.2 Fuel Use. The fuel use follows a simple sequence of operations. Fuel management for the first and last segments of every flight is identical. The fuel distribution for any flight is a function of the total fuel load and the possible utilization of the optional fuel transfer capability. Variations in fuel distribution lead to alternate sequences used during the midportion of cruise, as shown in Fig. 5-4.

The main tanks provide continuous backup during use of the auxiliary tank fuel. After initiation of fuel use from any tank, the tank is used to depletion, with no cycling required.

5.3 Loading Conditions. Table 5-B details the payload and fuel loading required to build up to the various design weights for the B-2707 (P&WA). This airplane was chosen for the detailed balance analysis because it was felt to be more conservative to examine the airplane with the most aft OEW cg. The B-2707 (GE) would be similar except for the minor changes due to difference in OEW and maximum design landing weight.

5.4 Balance and Loading Charts. Balance and loading charts for three missions are shown in Figs. 5-5, 5-6, and 5-7. The primary balance characteristics illustrated by the balance charts are summarized below.

The airplane cg in the zero-fuel-weight condition (OEW plus payload, with wings forward) must fall within the landing limits defined for the wing sweep of 30 deg. Any operational tolerances desired for passenger seating, inflight movement, and fleet variation must be incorporated if applicable.

With the cg of the airplane within the landing limits as described above, use of the standard fuel loading and appropriate fuel use sequence, including optional utilization of fuel transfer, ensures that the airplane center of gravity never exceeds any structural or aerodynamic limit during normal operation. Moving the wing to 42-deg sweep moves the airplane cg within the 42-deg aft limit for all gross weights. Moving the wing to 30-deg sweep moves the airplane cg within the 30-deg aft limit for gross weights equal to or below the maximum design landing weight.

5.4.1 Loading Tolerances. The passenger loading loops shown are for front-to-rear and rear-to-front seating, following the standard convention of window seats being filled first, aisle seats next, and remaining seats last. The loops as drawn are an envelope of the most extreme loading conditions for the 277-passenger International Mix airplane, assuming no knowledge of the distribution of passengers between the two compartments. For operational use this is considered overly conservative, as the distribution between first class and tourist is known in present normal airline operations. It is also believed that

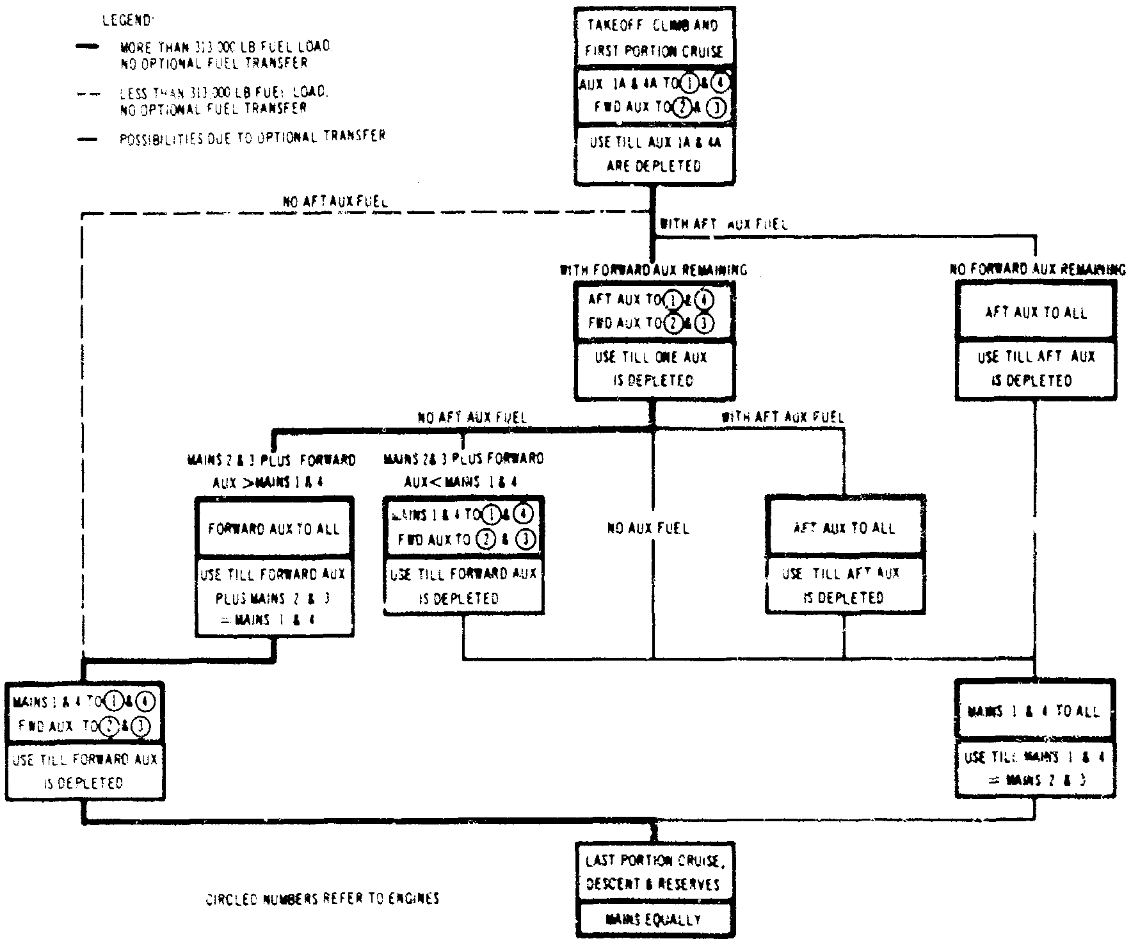


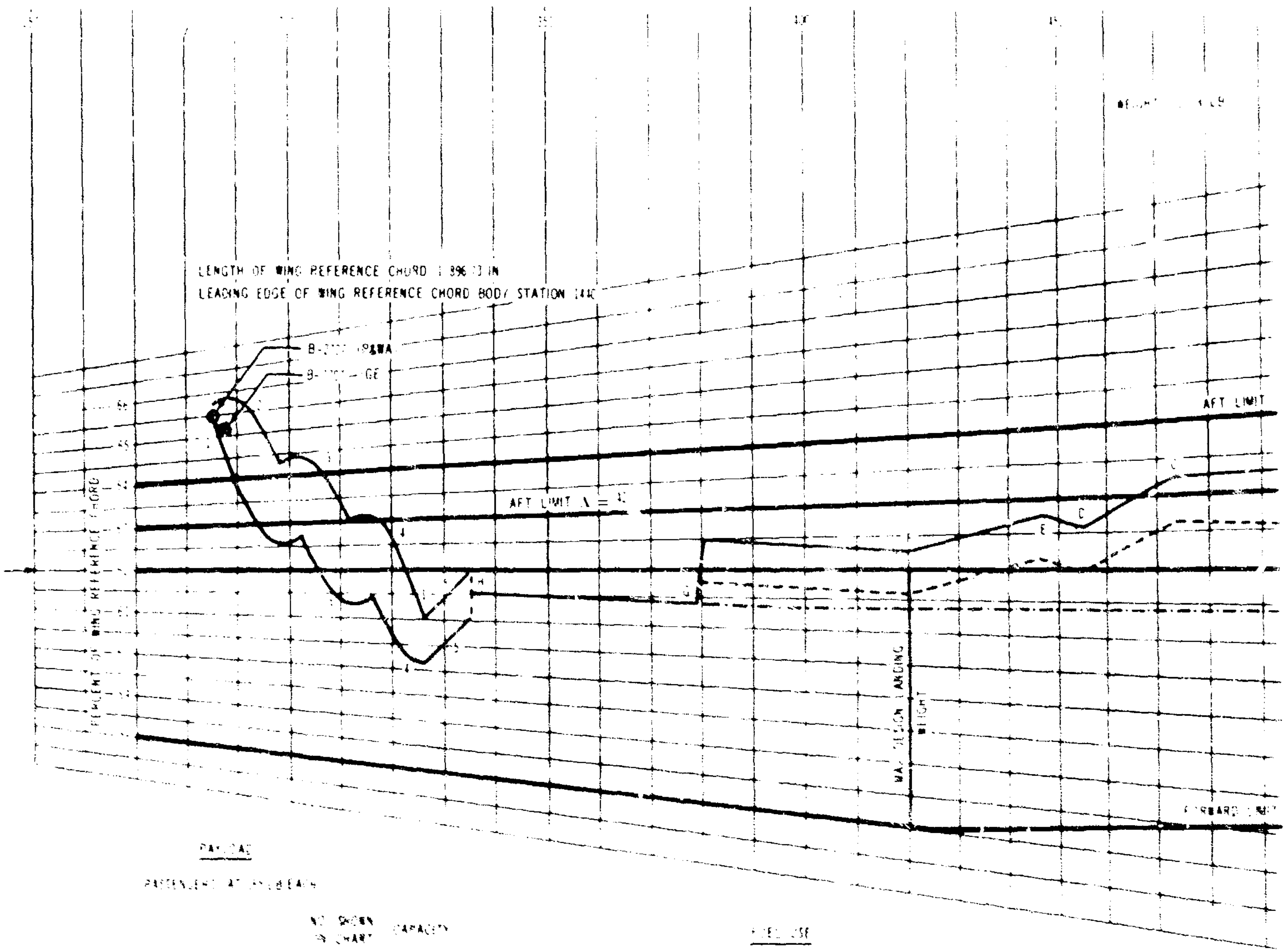
Figure 5-4. Fuel Use

Table 5-B. Airplane Loading Conditions

Condition	B-2707 (P&WA) Weights (lb)	Horizontal Arm	Horizontal Moment	CG % CR	Vertical Arm	Vertical Moment
Operational Empty Weight gear down Λ = 30 deg.	285,000	2,682	764,370,000	65.5	210	59,850,000
Passengers:						
? first class	4,950	1,021	5,053,950		231	1,143,450
247 tourist	40,755	2,079	84,729,645		247	10,066,485
Cargo, aft	12,040	3,225	38,829,000		285	3,431,400
Cargo, forward	17,255	1,559	26,900,545		185	3,192,175
(Allowable payload)	(75,000)	(2,074)	(155,513,140)		(238)	(17,833,510)
Maximum zero fuel weight gear down Λ = 30 deg.	360,000	2,555	919,883,140	58.8	216	77,683,510
Fuel:						
Main Tank No. 1	27,800	3,116	86,624,800		230	6,394,000
Main Tank No. 2	15,473	1,998	30,915,054		192	2,970,816
Main Tank No. 3	15,473	2,122	32,833,706		192	2,970,816
Main Tank No. 4	27,800	3,116	86,624,800		230	6,394,000
Forward Auxiliary	126,888	2,438	309,352,944		196	24,870,048
Aft Auxiliary	666	3,502	2,332,332		268	178,488
Outboard Auxiliary Tanks 1A & 4A	100,900	2,692	271,622,800		216	21,794,400
Total Expendable	(315,000)	(2,604)	(820,306,436)		(208)	(65,572,568)
Transfer 18,000 lb. of fuel from forward to aft auxiliary			19,152,000			1,296,000

Table 5-B. Airplane Loading Conditions (Cont)

Condition	B-2707 (P&WA) Weights (lb)	Horizontal Arm	Horizontal Moment	CG %C_R	Vertical Arm	Vertical Moment
Maximum design taxi weight gear down Λ = 30 deg.	675,000	2,608	1,759,341,576	61.6	214	144,552,078
Use fuel from:						
Outboard Auxiliary Tanks 1A & 4A	-1,500	2,692	-4,038,000		216	-324,000
Forward auxiliary	-1,500	2,438	-3,657,000		196	-294,000
Maximum design takeoff weight gear down Λ = 30 deg.	672,000	2,607	1,751,646,576	61.5	214	143,934,078
Use fuel from:						
Outboard auxiliary tanks 1A & 4A	-2,000	2,692	-5,384,000		216	-432,000
Forward auxiliary	-2,000	2,438	-4,876,000		196	-392,000
Retract landing gear Λ = 30 deg			139,000			3,105,000
Maximum design flight weight gear up, flaps down Λ = 30°	668,000	2,607	1,741,525,576	61.5	219	146,215,078
Use fuel from:						
Outboard auxiliary tank 1A & 4A	-1,000	2,692	-2,692,000		216	-216,000
Forward auxiliary	-1,000	2,438	-2,438,000		196	-196,000
Sweep wing to Λ = 42 deg.			8,480,400			849,100
Raise flaps			- 118,425			164,446
Maximum design flight weight gear up, flaps up Λ = 42 deg.	666,000	2,620	1,744,757,551	62.2	220	146,816,624
Sweep wing to Λ = 72 deg.			16,066,000			1,981,300
Use fuel from:						
Outboard auxiliary **tanks** 1A & 4A	-96,400	2,868	-276,475,200		236	-22,750,400
Forward auxiliary	-96,400	2,438	-235,023,200		196	-18,894,400
Supersonic cruise, wings empty gear up Λ = 72 deg.	473,200	2,640	1,249,325,151	63.3	226	107,153,124
Use fuel from:						
Forward auxiliary	-7,988	2,438	-19,474,744		196	-1,565,648
Aft auxiliary	-18,666	3,502	-65,368,332		268	-5,002,488
Main tanks 1 & 4	-25,600	3,116	-79,769,600		230	-5,888,000
Main tanks 2 & 3	- 946	2,060	-1,948,760		192	- 181,632
Sweep wing to Λ = 30 deg.			-7,580,000			- 902,400
Lower gear and flaps			-20,575			-3,269,446
Maximum design landing weight gear down, flaps down Λ = 30 deg.	420,000	2,560	1,075,163,140	59.0	215	90,343,518
Operational empty weight gear down Λ = 30 deg	285,000	2,682	764,370,000	65.5	210	59,850,000
Water ballast	11,000	867	9,537,000		178	1,958,000
Fuel mains equalize	14,000	2,588	56,232,000		211	2,954,000
Retract gear, raise flaps Λ = 30 deg.			20,575			3,269,446
Minimum flying weight gear up Λ = 30 deg.	310,000	2,613	810,159,575	61.8	219	68,031,446



PAYLOAD

PASSENGERS AT [illegible] LB EACH

		NO. SHOWN IN CHART	CAPACITY
1	FIRST CLASS	[illegible]	[illegible]
2	TOURIST – WINDOW	83	83
3	TOURIST – AISLE	83	83
4	TOURIST – REMAINING	[illegible]	[illegible]

CARGO AT [illegible] LBS PER CU FT

5	AFT COMPARTMENT	[illegible]	[illegible]
	FWD COMPARTMENT	[illegible]	[illegible]

FUEL USE

A-B TAXI, TAKEOFF AND CLIMB, SWEEP WING [illegible]
FEED ENGINES 1 & 4 FROM OUTBD AUX 1A & 4A
FEED ENGINES 2 & 3 FROM FWD AUX

B-C ACCELERATION AND CRUISE
CONTINUE ABOVE MANAGEMENT UNTIL OUTBD AUX 1A & 4A ARE DEPLETED

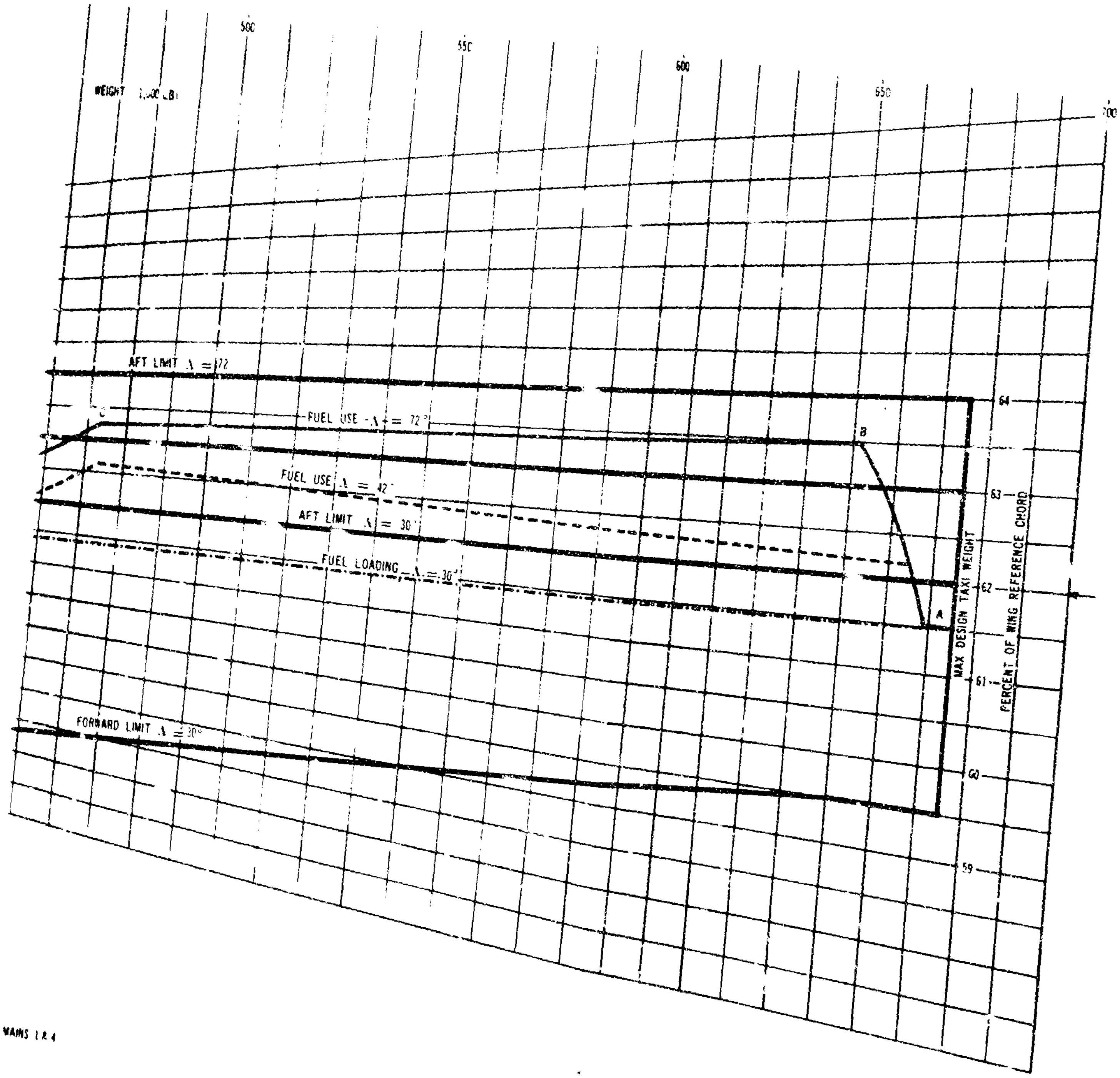
C-D FEED ENGINES 1 & 4 FROM AFT AUX UNTIL DEPLETED
FEED ENGINES 2 & 3 FROM FWD AUX

D-E FEED ALL ENGINES FROM FWD AUX UNTIL MAINS [illegible] FWD AUX EQUAL MAINS 1 & 4

E-F FEED ENGINES [illegible] FROM MAINS 1 & 4
FEED ENGINES [illegible] FROM FWD AUX UNTIL DEPLETED

F-G [illegible] SWEEP WING [illegible] AND
[illegible] ENGINES [illegible] FROM MAIN TANKS

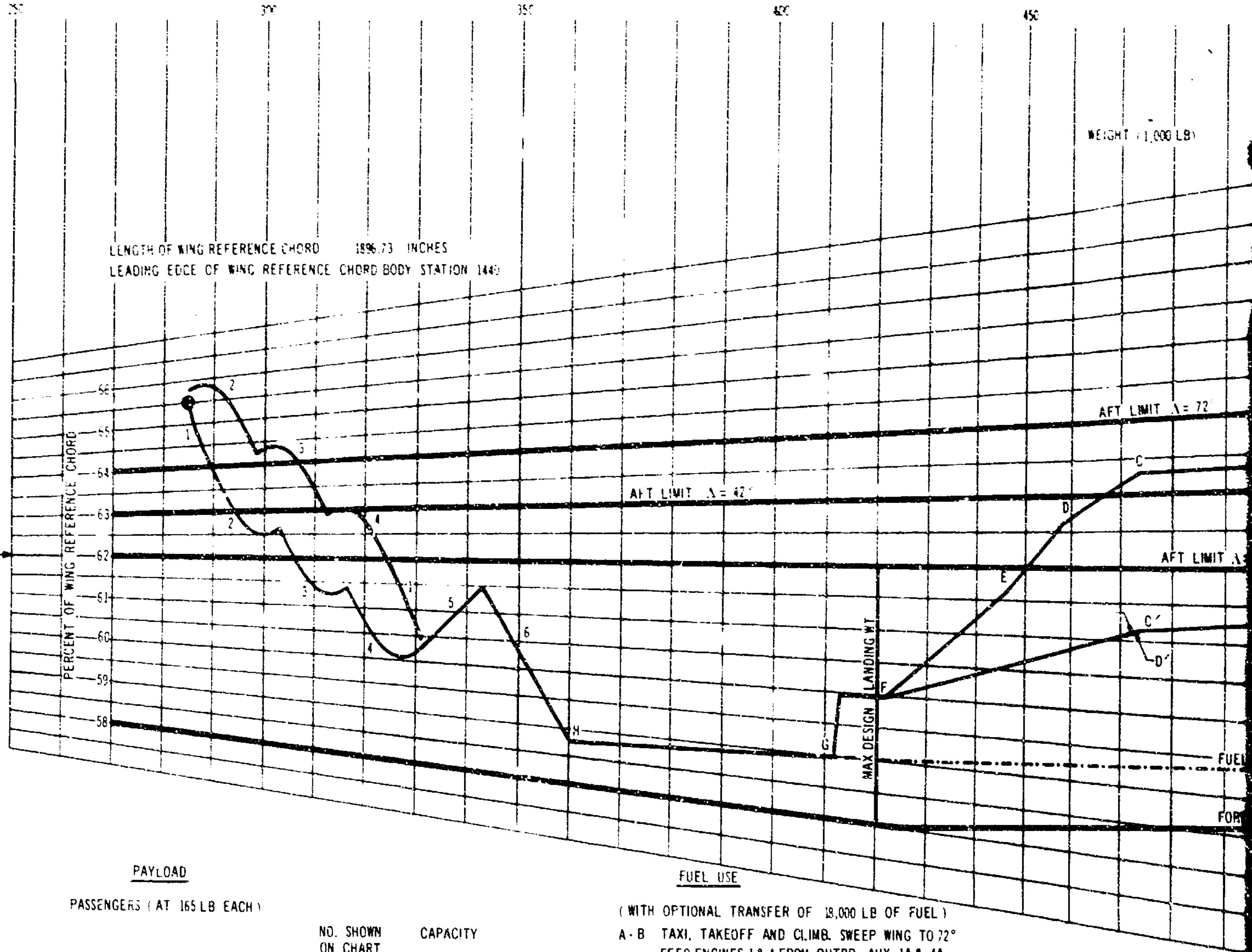
G-H RESERVE FUEL IN MAIN TANKS [illegible]



MAINS 1 & 4

ß

Figure 5-5 Balance and Loading Chart, 50,000-lb Nominal Payload



PAYLOAD

PASSENGERS (AT 165 LB EACH)

	NO. SHOWN ON CHART	CAPACITY
1. FIRST CLASS	30	30
2. TOURIST - WINDOW	83	83
3. TOURIST - AISLE	83	83
4. TOURIST - REMAINING	81	81
CARGO (AT 10 LB PER CU FT)		
5. AFT COMPARTMENT	12,040	12,040
6. FWD COMPARTMENT	17,255	19,020

FUEL USE

(WITH OPTIONAL TRANSFER OF 18,000 LB OF FUEL)

A - B TAXI, TAKEOFF AND CLIMB. SWEEP WING TO 72°
FEED ENGINES 1 & 4 FROM OUTBD AUX 1A & 4A
FEED ENGINES 2 & 3 FROM FWD AUX

B - C ACCELERATION AND CRUISE
CONTINUE ABOVE MANAGEMENT UNTIL OUTBD AUX 1A & 4A ARE DEPLETED

C - D FEED ENGINES 1 & 4 FROM AFT AUX
FEED ENGINES 2 & 3 FROM FWD AUX UNTIL DEPLETED.

D - E FEED ALL ENGINES FROM AFT AUX UNTIL DEPLETED.

E - F FEED ALL ENGINES FROM MAINS 1 & 4 UNTIL MAINS 1 & 4 EQUAL MAINS 2 & 3

F - G DESCEND, SWEEP WING TO 30°, AND LAND
FEED ENGINES DIRECT FROM MAIN TANKS

G - H RESERVE FUEL IN MAIN TANKS EQUALLY.
(NO TRANSFER OF FUEL)

A′ - B′ SAME AS A - B

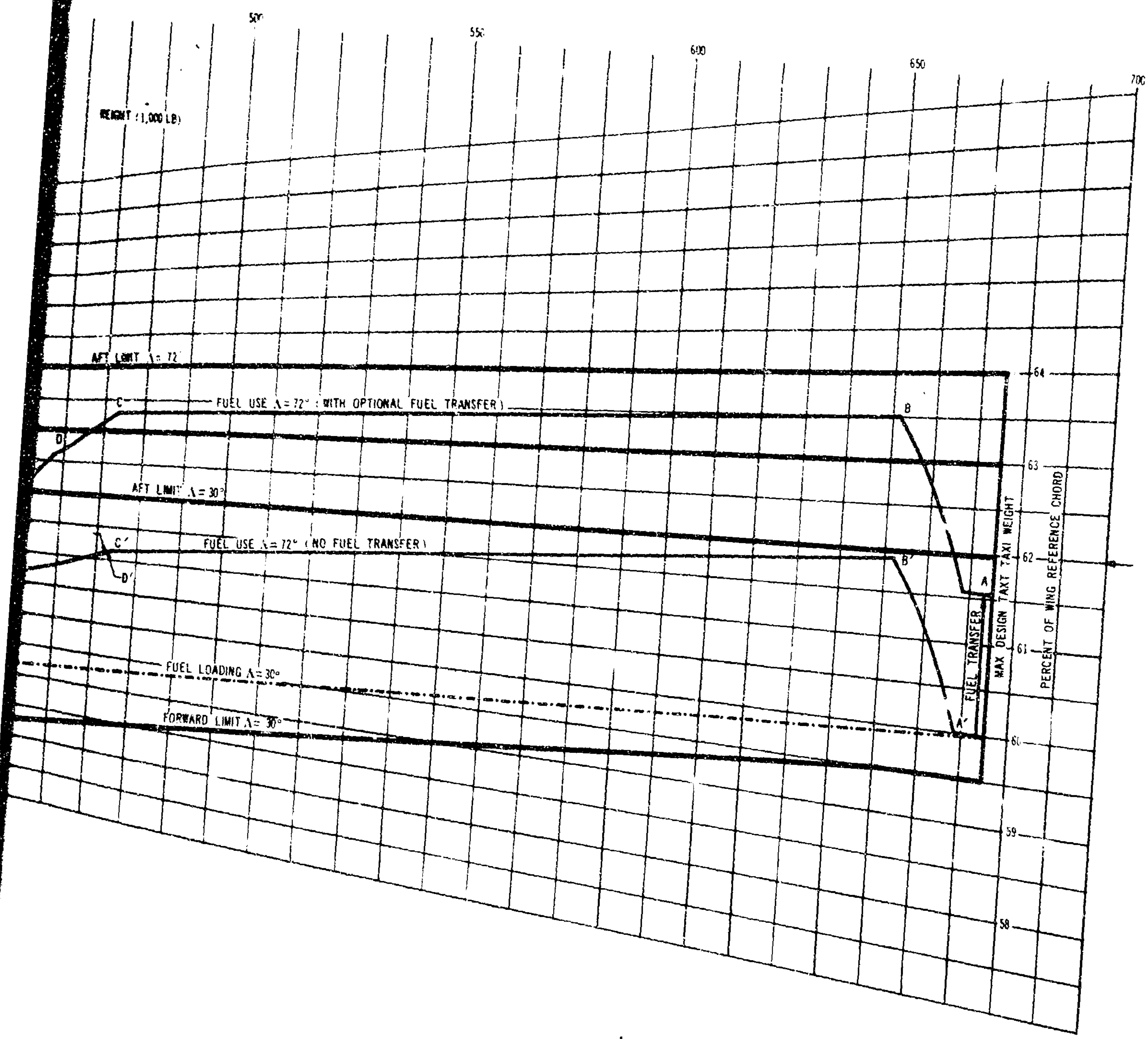
B′ - C′ SAME AS B - C

C′ - D′ FEED ENGINES 1 & 4 FROM AFT AUX UNTIL DEPLETED
FEED ENGINES 2 & 3 FROM FWD AUX

D′ - E′ FEED ALL ENGINES FROM FWD AUX UNTIL MAINS 2 & 3 PLUS FWD AUX EQUAL MAINS 1 & 4

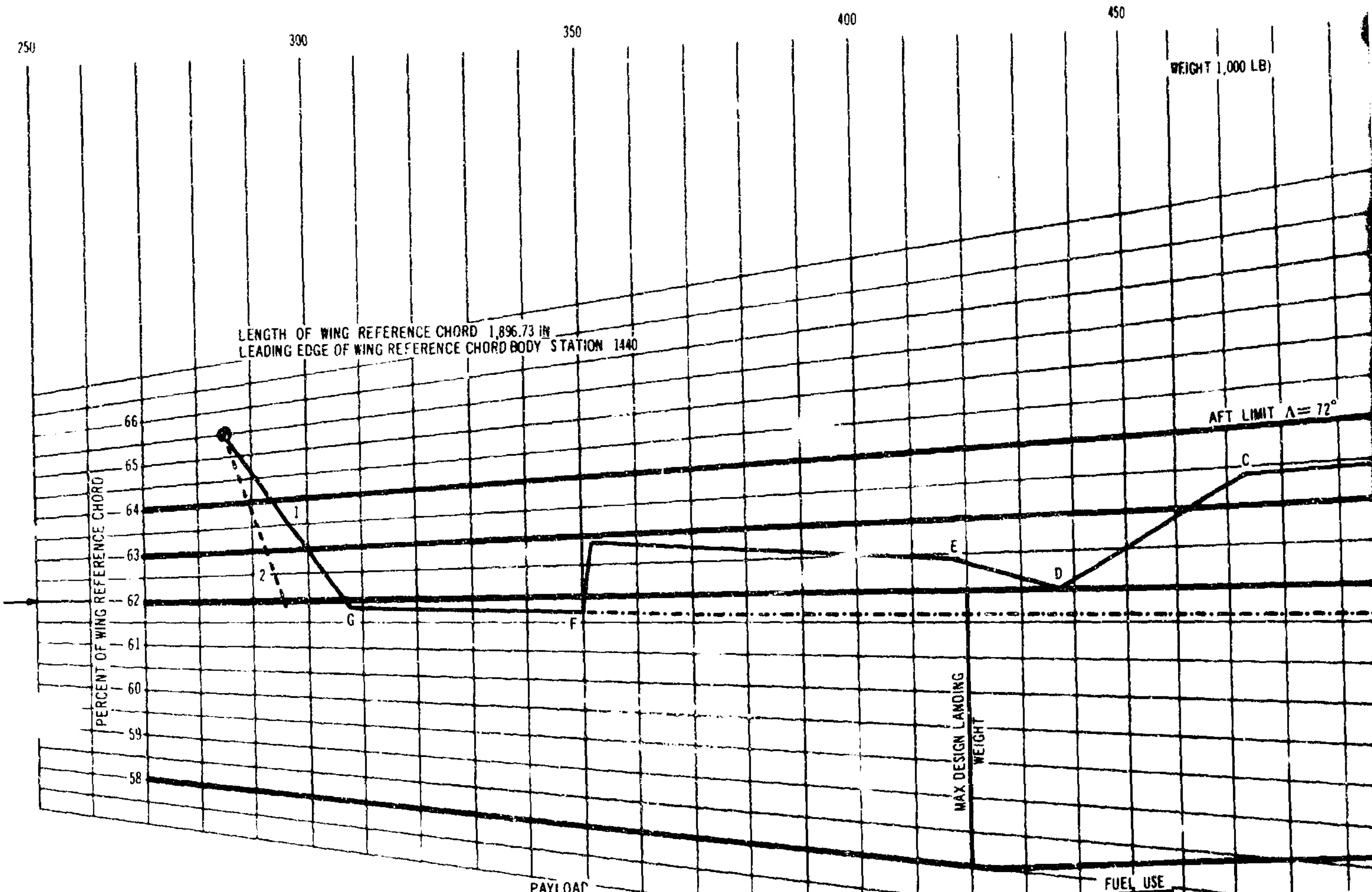
E′ - F′ FEED ENGINES 1 & 4 FROM MAINS 1 & 4
FEED ENGINES 2 & 3 FROM FWD. AUX UNTIL DEPLETED
REMAINDER OF FLIGHT SAME AS WITH FUEL TRANSFER

A



B

Figure 5–6 Balance and Loading Chart, 75,000–lb Payload



1. PAYLOAD OF 22,900 LB, PRIMARILY IN FWD CARGO COMPARTMENT. APPROXIMATELY 17,000 LB IN FWD COMPARTMENT WILL BRING CG WITHIN LIMITS.
2. WATER BALLAST. 11,000 LB REQUIRED FOR ZERO PAYLOAD.

FUEL LOAD 367,100 LB

A - B TAXI, TAKEOFF AND CLIMB, SWEEP WING TO 72°
FEED ENGINES 1 & 4 FROM OUTBD AUX 1A & 4A
FEED ENGINES 2 & 3 FROM FWD AUX

B - C ACCELERATION AND CRUISE
CONTINUE ABOVE MANAGEMENT UNTIL OUTBD AUX 1A & 4A ARE DEPLETED.

C - D FEED ENGINES 1 & 4 FROM AFT AUX UNTIL DEPLETED
FEED ENGINES 2 & 3 FROM FWD AUX.

D - E FEED ALL ENGINES FROM FWD AUX UNTIL DEPLETED

E - F CRUISE, DESCEND, SWEEP WING TO 30°, AND LAND
FEED ENGINES DIRECT FROM MAIN TANKS

F - G RESERVE FUEL IN MAIN TANKS EQUALLY.

A

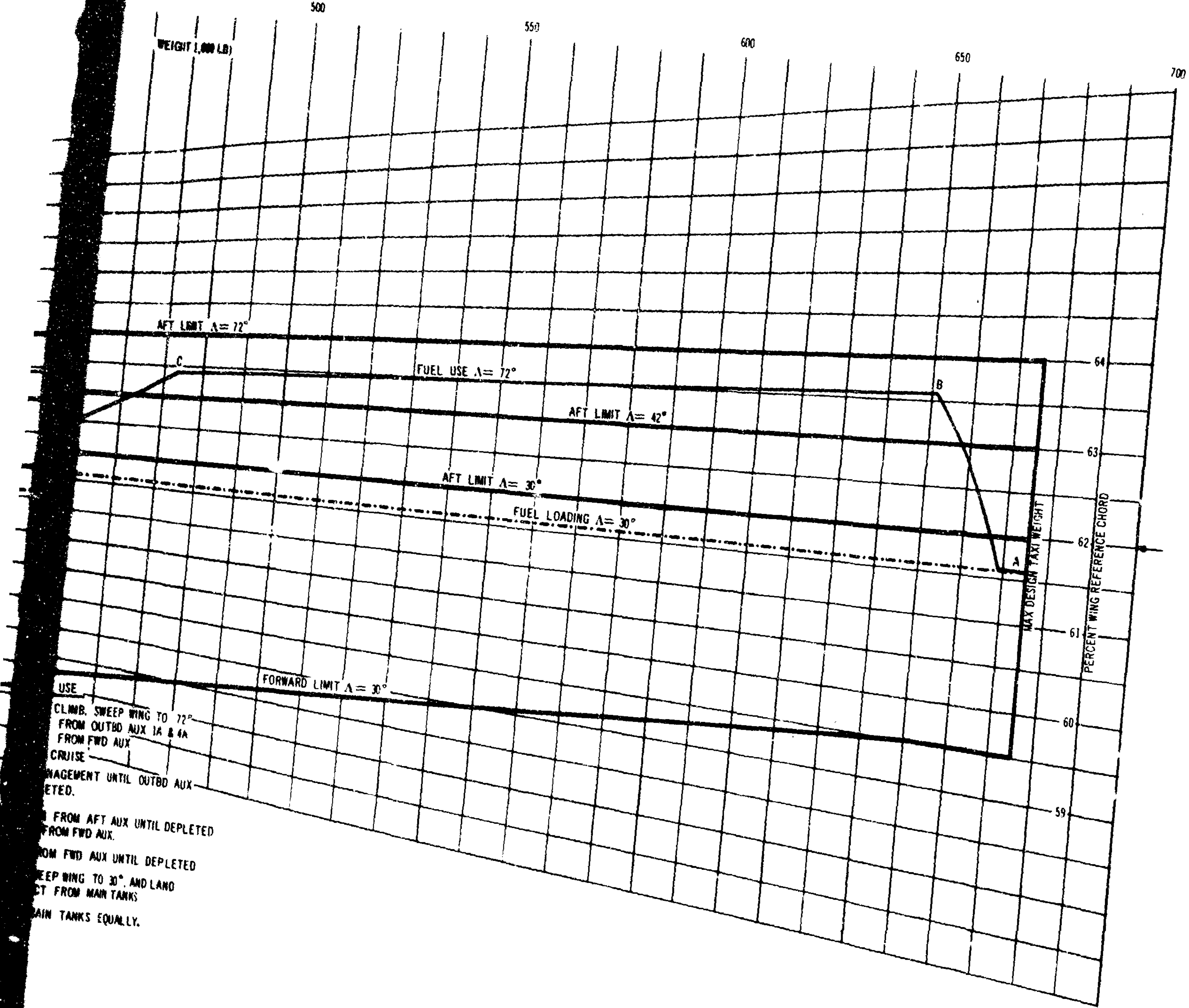


Figure 5-7 Balance and Loading Chart, Maximum Range Flight

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some form of seating control will be required for airplanes of this size to minimize the uncertainty of the cg location and thus improve overall performance. Such seating control could perhaps be by some type of zone loading, maintaining the concept of unrestricted seating within the zones. Another means of determining cg with certainty would be by means of an onboard cg indicator as is planned for the Model 747.

On the balance charts, an aft inflight tolerance of 0.16 percent of wing reference chord at OEW is included. No forward allowance is incorporated as the forward limits are approached only during takeoff and landing, when the passengers are seated. The interior arrangement is such that the normal inflight movement is minimized. The services and attendants are distributed throughout the length of the compartment instead of being concentrated at the ends. Derivation of typical inflight allowances are given in Table 5-C.

No fleet tolerance is shown on the charts. If a fleet tolerance value is desired ± 0.25 percent of the wing reference chord would be roughly comparable to the FAA allowable fleet tolerance of ±0.5 percent MAC.

5.4.2 Nominal Payload Chart. The balance and loading chart for a nominal payload of 50,000 lb is shown in Fig. 5-5. Effects of passenger loading, baggage distribution, fuel loading and management and wing sweep are shown. The payload consists of 27 first class passengers and 223 tourist passengers with a baggage allowance of 35 lb per passenger. The OEW cg of the B-2707 (GE) is shown for comparison.

Fuel loading and management follows the sequence detailed in Par. 5.2. A fuel use curve is also shown for a wing sweep of 42 deg. These curves represent the nominal cg of the airplane during the course of the flight. The applicable operational tolerances must be applied to this nominal cg to obtain the extremes.

5.4.3 Maximum Payload Chart. The balance chart for a payload of 75,000 lb is shown in Fig. 5-6. The payload consists of 277 passengers and 29,295 lb of baggage and cargo. The significant feature of this chart is the example of optional fuel transfer. By transferring 18,000 lb of fuel to the aft auxiliary tank, the cg for takeoff and the first part of cruise is practically identical to the nominal payload mission. For comparison, a fuel use line assuming no transfer is also shown.

5.4.4 Maximum Range Chart. A balance chart for maximum range is shown in Fig. 5-7, in which the fuel load is 367,100 lb. This chart illustrates the use of the water ballast tank. For zero payload, 11,000 lb of water are required. If cargo is available, 17,000 lb of cargo in the forward compartment will bring the cg within acceptable limits.

If passengers are assumed to be located at the compartment centroids, with the baggage at 35 lb per passenger loaded in the forward compartment, approximately 130 passengers are required for acceptable balance. If the aft 94 tourist seats are blocked off, a minimum of 99 passengers are required. Acceptable balance is obtained with fewer passengers if cargo is available.

5.5 Ground Handling Balance Characteristics. With the main gear manifold locked out, the static ground stability of the airplane is very good. With standard fueling procedures, the airplane may be fueled at any wing sweep, with no crew or payload aboard. For this condition, the airplane may taxi or be towed with the wing in the forward sweep position and with fuel loads greater than 180,000 lb. When loaded ready for flight, the airplane may be taxied with the wing at any sweep.

Table 5-C. Inflight Movement Calculation

Centroids	Body Station
Forward lavatory	773
Forward attendants (2)	805
Aft first class passenger	1152
Forward tourist passenger	1210
Forward tourist galleys (2) average	1542
Forward tourist lavatories (3) average	1571
Forward tourist attendants (2)	1542
Forward mid tourist passenger	1650
Mid tourist passenger	2228
Mid tourist attendants (2)	2306
Aft tourist passenger	2709
Aft tourist lavatories (2) average	2960
Aft tourist galleys (2) average	2964
Aft tourist attendants (2)	2970
Aft Movement	**Moment (in.-lb)**
(2) Forward attendants to aft first class	90,220
(3) Forward tourists to forward lavatories	178,695
(1) Forward mid tourist to aft lavatory	216,150
(1) Mid tourist to aft lavatory	120,780
(2) Forward tourist attendants to mid tourist	178,360
(1) Mid tourist attendant to aft galley	108,570
Total	892,775
At 285,000 lb = +3.1 in. = 0.16% C_R	
Forward Movement	
(1) Aft first class to forward lavatory	-62,535
(2) Forward tourist attendants to forward tourist	-91,520
(2) Mid tourists to forward lavatories	-216,810
(1) Aft tourist to forward lavatory	-187,770
(1) Mid tourist attendant to forward tourist galley	-99,320
(2) Aft tourist attendants to mid tourist	-192,920
Total	-850,875
At 285,000 lb = -3.0 in. = -0.16% C_R	

6.0 MOMENT OF INERTIA

The moments of inertia and products of inertia about the airplane reference axes for the nominal flight are presented in Figs. 6-1 and 6-2. These values are consistent with the center of gravity and fuel management shown in Fig. 5-5.

The airplane roll axis is taken parallel to the airplane reference waterline. As shown by the small product of inertia term, this corresponds very closely to the airplane principal axis, the angle between them being less than 1 deg. The roll and yaw moments of inertia shown are thus within 1 percent of the values about the principal axes.

The airplane moments of inertia were calculated by a computer program that operates on the geometric and mass properties of over 270 panel points to obtain total airplane values. Sixteen different conditions were analyzed to obtain the nominal flight.

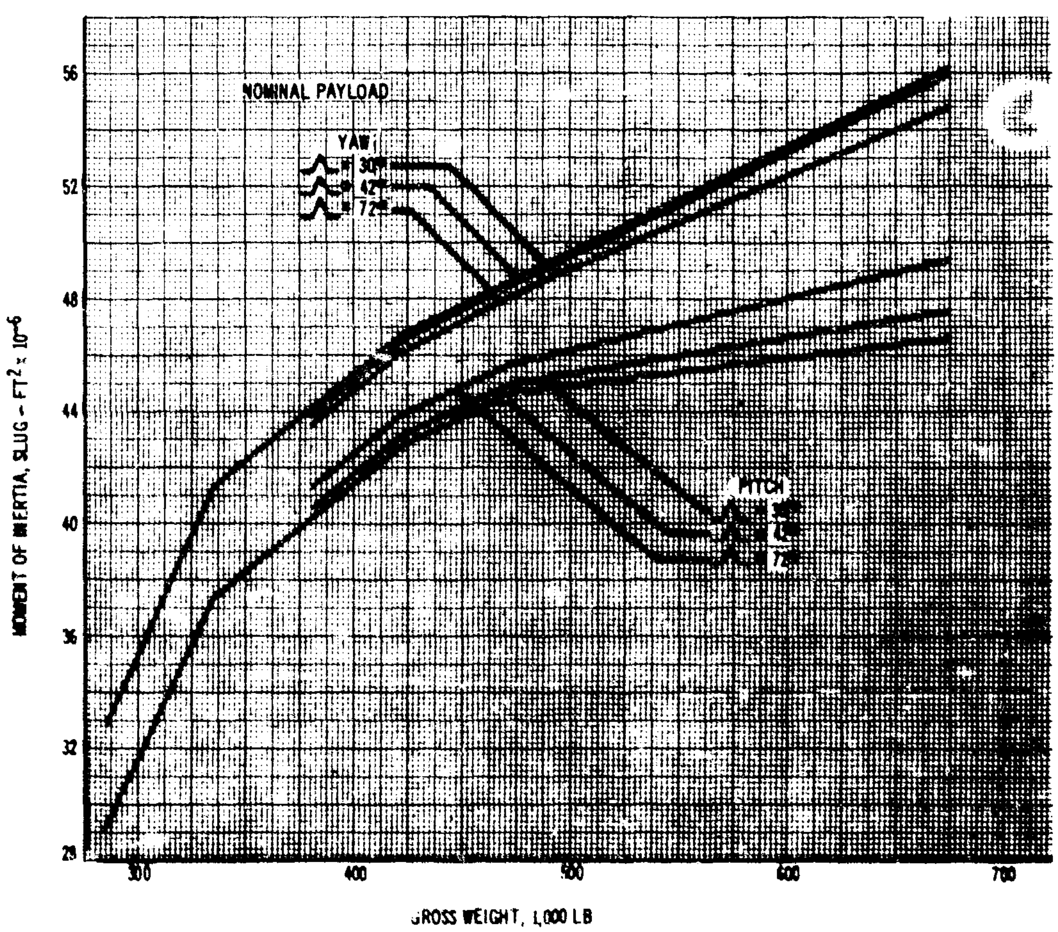

Figure 6-1. Moment of Inertia, Pitch and Yaw

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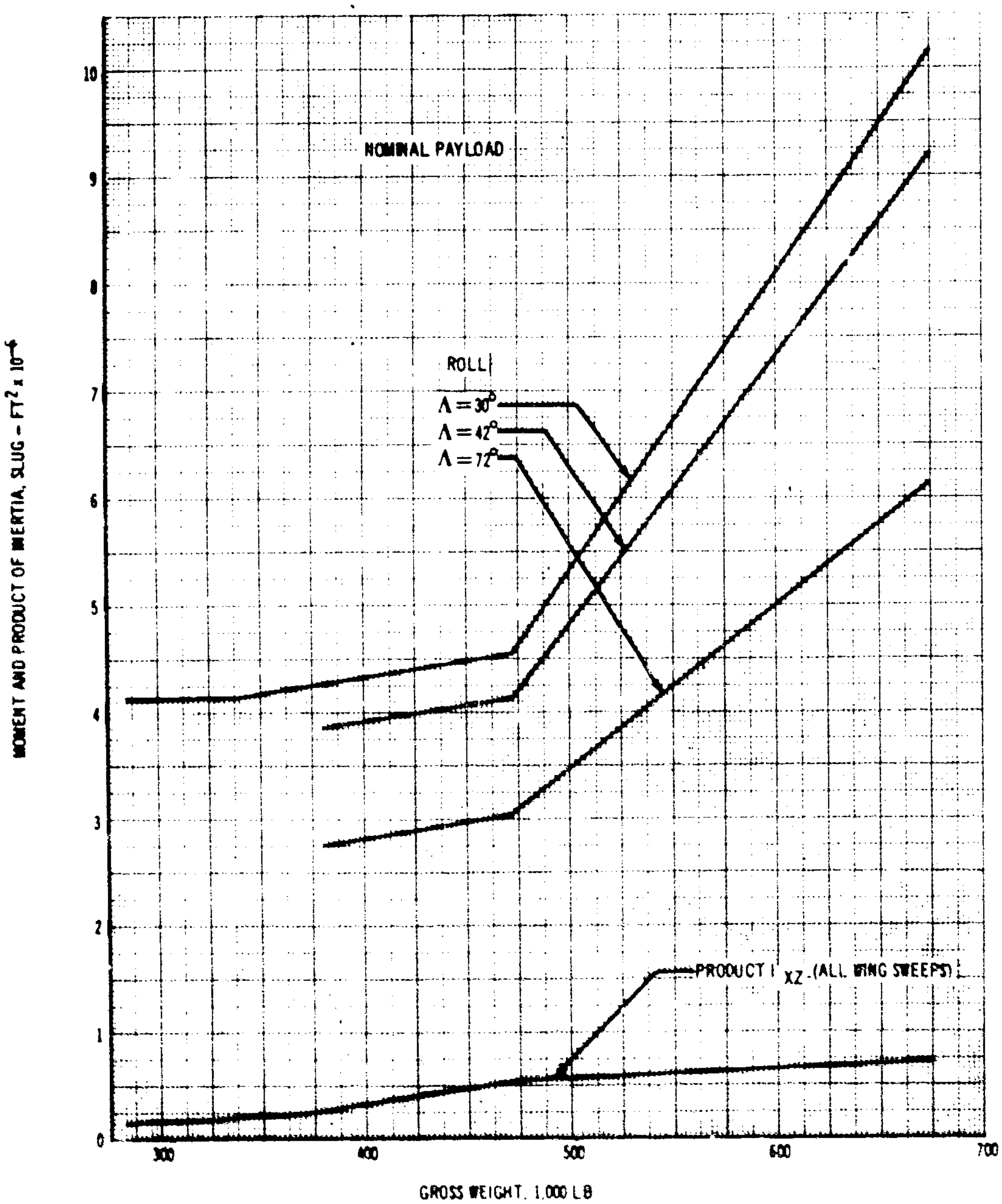


Figure 6-2. Moment of Inertia, Roll and Product

CONTENTS

7.0 DESIGN DATA REQUIREMENTS AND DETAIL WEIGHTS

This section presents a detail breakdown of the group weight statement for the 635,000-lb design point airplane as tabulated in Sec. 3 of this document. The information for each weight group will include the following where applicable:

a. Descriptive summary

b. Detail weights

c. Weight determination methods and design data

Difference in the breakdown of detail weights between the B-2707 (GE) and the B-2707 (P&WA) are identified.

7.1 Wing. The structural diagram is shown in Airframe Design Report, V2-B2707-6-2, Fig. 3-2. The wing, along with the horizontal tail, forms the total airplane lifting surface when the wing leading edge sweep is 72 deg. In this position, the wing and horizontal tail mate to form a smooth airfoil section. The two are attached by a shear-type roller and socket assembly cantilevered from the wing rear spar and the horizontal tail front spar. The reference area of the wing and horizontal tail combination is 9,000 sq ft, of which the horizontal tail has 2,478 sq ft of exposed area. The airfoil section is comprised of one chord for both the wing and horizontal tail, with one thickness ratio of 2.85 percent at the side of body.

The primary structure is a conventional two-spar box utilizing Ti 6Al-4V material. The inspar ribs consist of a sine-wave corrugated web welded to flat plate chord members. See Airframe Design Report, V2-B2707-6-2, Fig. 3-3. Normal rib spacing is 27 in. The only chordwise joints in the main wing box are in the local area of the pivot.

The strake structure, forward of the front spar, is supported jointly by the body and the wing box. Lightweight integral type structure is used to attach the wing strake to the body, see Airframe Design Report, V2-B2707-6-2, Fig. 3-15.

The chord length of the leading edge slats is 48 in. on the inboard wing and 35 in. on the outboard movable wing. The outboard wing slat nose is extended on a track as shown on the typical slat design drawings.

The inboard wing flap system serves as a debris deflector to protect the engine from foreign objects displaced by the landing gear. The engine inlet air is directed from the wing upper surface down through the wing to the inboard engine. The flap cavity is covered by a lower surface door when flaps are retracted.

The outboard wing trailing edge is comprised of a double-slotted flap, spoilers, aileron, movable upper surface panel and a hinged lower surface panel that serve to form the airfoil section with the horizontal tail when the wing is fully swept. The wing-to-tail tie beams are enclosed with the flap tracks. See Airframe Design Report, V2-B2707-6-2, Fig. 3-5.

Minimum gages determined for the wing are shown in Par. 7.1.2.

7.1.1 Detail Weights

		Weight (lb)	
Wing			
Total			63,900
Inboard Wing		29,730	
Skin and stiffeners *	4,285		
Spar web and stiffeners*	990		
Interspar ribs*	645		
Pivot section* (see Table 7-A)	7,580		
Forward strake (4.45 psf)	5,410		
Fixed leading edge (3.18 psf)	1,025		
Slats	2,985		
Aft fixed structure	1,220		
Flap and door system	3,095		
Landing gear door (4.58 psf)	1,220		
Fittings, sweep actuator	185		
Pivot fairing (1.3 psf)	610		
Non-optimum factor, 3.6 percent of asterisk items	480		
Outboard Wing		34,170	
Skin and stiffeners*	13,790		
Spar web and stiffeners*	1,515		
Interspar ribs*	2,400		
Pivot section* (see Table 7-A)	4,120		
Fixed leading edge (3.50 psf)	1,495		
Slats	2,300		
Fixed trailing edge	675		
Trailing edge flap section	5,425		
Spoilers	795		
Aileron	435		
Tip	120		
Access doors, box	125		
Fittings, sweep actuator	185		
Non-optimum factor, 3.6% of asterisk items	790		

7.1.2 Weight Determination Methods and Design Data. The weight of the primary structure is determined analytically as described in Phase IIA Airframe Design Report, D6-8680-6, page 39, using ultimate wing shears, moments, and torsions as shown for the critical subsonic, transonic, and supersonic maneuver conditions. For a substantiation of the load conditions, see Airframe Design Report, V2-B2707-7, Par. 3.1.1. A substantiation of the allowable stress is presented in Airframe Design Report, V2-B2707-6-2, Par. 4.2.

The fatigue considerations on stress levels have been analyzed and determined to have minor effect upon the allowable stresses. A discussion and plot of 1-g stress levels versus flight time are presented in V2-B2707-6-2, Par. 5.6.

The weight of the pivot components is based on the design shown in Airframe Design Report, V2-B2707-6-2, Figs. 3-22 and 3-23. The critical design moment condition for the pivot is the high gross weight, flaps up, subsonic maneuver at 42-deg leading edge sweep.

The weights of control surfaces and secondary structure are based on drawings and substantiated by comparison to statistical data on existing aircraft.

		Reference Positions	
		72 deg	30 deg
Area, sq ft	Reference (including Horizontal Tail)	9000	
	Basic Wing	5830	
Span, ft		105.74	174.28
Aspect ratio		1.24	
Taper ratio		0.293	
Thickness ratio			
(Includes horizontal tail)			
	Side of body @ WBL 67.5	0.0285	
	Pivot	0.0280	
	BL 375	0.0280	
	Tip	0.030	
Pivot location	Percent Semispan	29.3%	
	Percent Chord	42.8%	

Pivot Weight Summary	Table 7-A
Wing Control Surface Weights	Table 7-B
Skin & Stiffener Area	Fig. 7-1
Spar Web & Stiffener Area	Fig. 7-2
Wing Average Effective Depths	Fig. 7-3
Spar Depths	Fig. 7-4
Design Loads	Figs. 7-5 through 7-8
Load Reference Axis	Fig. 7-9

See Airframe Design Report, V2-B2707-6-2, for the following:

Structural Drawings	Figs. 3-1 through 3-24
Design Allowables	Fig. 4-7
1-g Stresses	Fig. 5-14 through 5-21

See Airframe Design Report, V2-B2707-7 for:

Speed restrictions for movable surface	Table 2-A

Critical Design Conditions

Minimum gages	Skin	Stiffeners	Honeycomb Face
Exterior			
Primary	0.030	.030	
Secondary	N/A	N/A	0.006
Interior	0.015	0.015	N/A

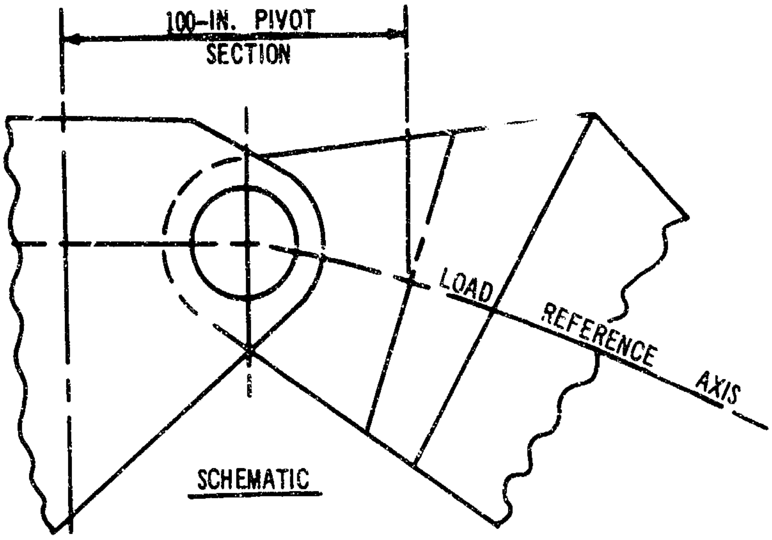
Primary structure

Skin and stiffeners

Inboard wing — Leading edge at high gross weight, subsonic ... /er, flaps down

Outboard wing	
(inboard 500 in.)	Leading edge at 42 deg, high gross weight, subsonic maneuver, flaps up
Primary structure	
(outboard 500 in.)	Leading edge at 72 deg, supersonic maneuver
Spar Web and Stiffeners	High gross weight, subsonic maneuver and taxi conditions
Strake	
Panels	7.5 psi limit internal pressure for refuel valve malfunction
Fuel bulkheads and spars	6-g ultimate crash loading
Body attachment	9-g ultimate crash loading

Table 7-A. Pivot Weight Summary



(For additional detail geometry, see ..irframe Design Report, V2-B2707-6-2.)

Component	Weight Per Airplane, lb Outboard Movable Wing	 Inboard Fixed Wing
Upper surface lugs	810	1,420
Lower surface lugs	1,390	1,980
Bearing plugs		1,480
Closure ribs	200	440
Bearing assembly and sleeves	540	350
Spars (barrel section)		450
Upper and lower surface panels	800	950
End ribs	170	230
Spar webs (closure to end rib)	110	130
Bolts (splice)	100	150
Subtotal	4,120	7,580
Total (100 in. pivot section)	11,700 lb	

Table 7-B. Wing Control Surface Weights

	Existing airplanes		B-2707			
Surface	Model	Average unit Weight (psf)	Location and Details	Unit weight (psf)	Area (sq ft)	Weight (lb)
			Outboard wing	3.63	120	435
Aileron	Boeing 727	3.94	Structure	2.75		330
			Hinges and supports	0.88		105
			Inboard wing			3,095
			Flap Triple Slot (structure only)	3.41	210	715
	Boeing 727 (Triple-slot structure only)	3.62	Forward upper panel	2.10	116	244
			Aft engine air door	2.22	59	131
			Linkages and supports			220
			Lower surface door	4.58	390	1,785
Flaps			Outboard wing			5,425
	Boeing KC-135		Flap double slot	(5.83)	(684)	(3,990)
	Boeing 707	5.85	Structure	2.83		1,940
	Boeing 720		Tracks and supports	3.00		2,050
			Movable Panels			(1,435)
			Upper surface	1.97	209	412
			Lower surface	2.20	464	1,023
			Lateral control (37-in. chord)	3.68	113.1	417
			Structure	2.55		289
			Hinges and supports	1.13		128
	Boeing 727 (25-in. chord)	2.74	Low-speed spoilers			378
Spoilers	Boeing 707		Inboard (54-in. chord)	(3.49)	(60.4)	(211)
		3.21	Structure	2.45		148
	Boeing 720		Hinges and supports	1.04		63
			Outboard (25-in. chord)	(2.67)	(62.5)	(167)
			Structure	1.92		120
			Hinges and supports	0.75		47
			Inboard wing (48-in. chord	7.11	420	2,985
			Structure	4.13		1,735
			Tracks and supports	2.98		1,250
Slats	Boeing 727 (24-in. chord)	4.54	Outboard wing (35-in. chord)	5.85	393	2,300
			Structure	3.18		1,250
			Tracks and supports, -Main	1.68		660
			-Nose	0.99		390

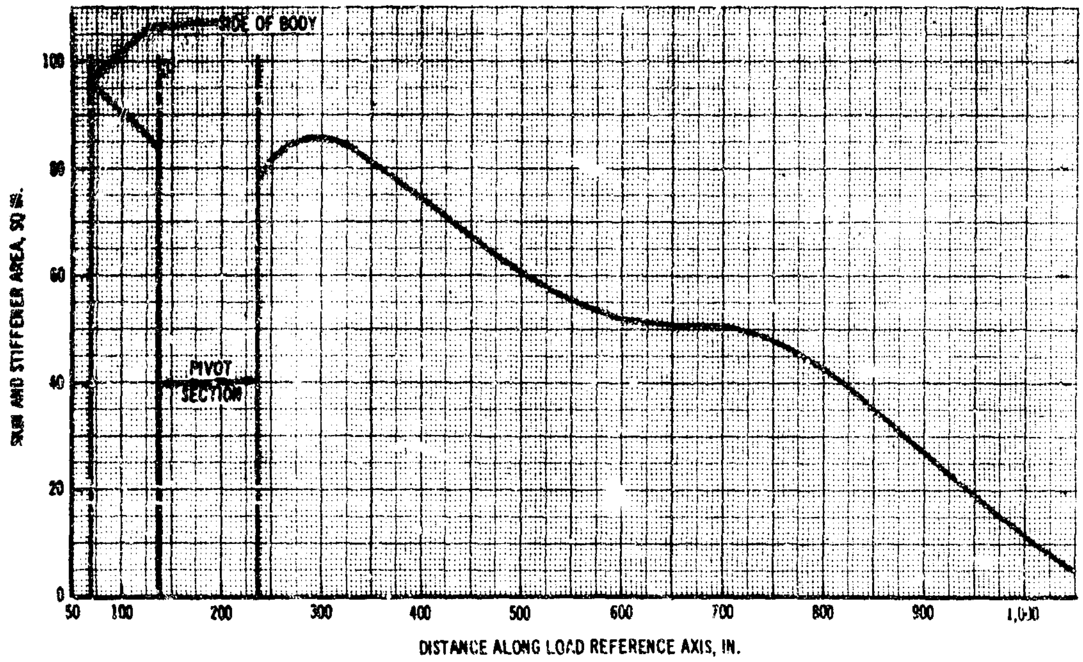


Figure 7-1. Wing Skin and Stiffener Area

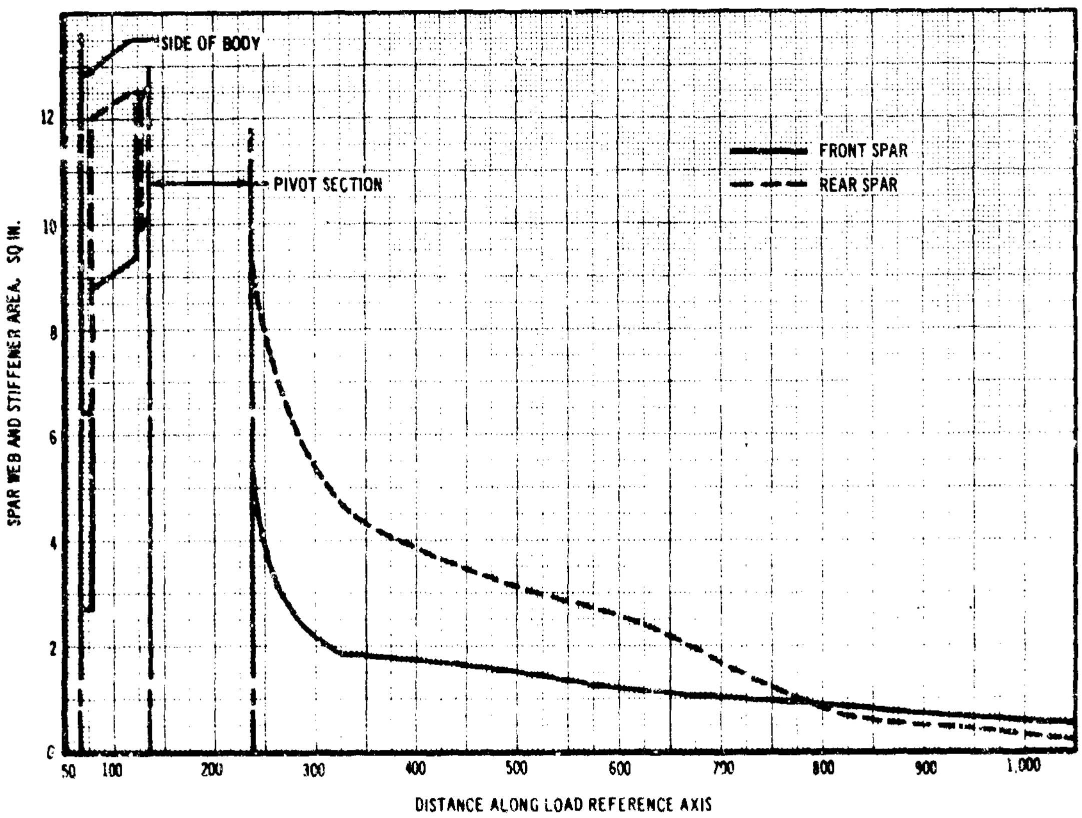


Figure 7-2. Wing Spar Web and Stiffener Aera

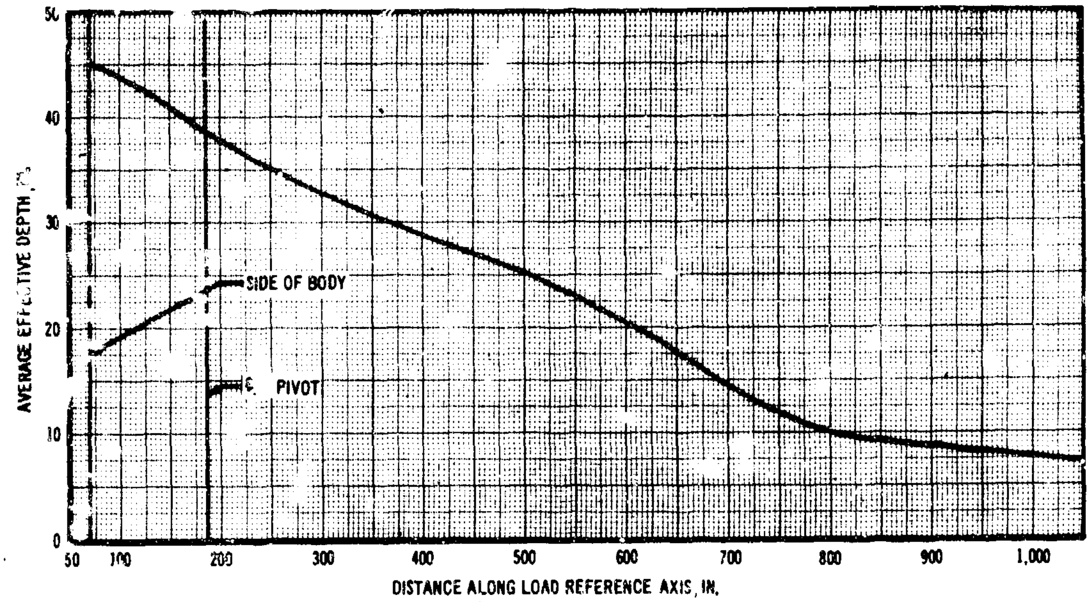


Figure 7-3. Wing Average Effective Depths

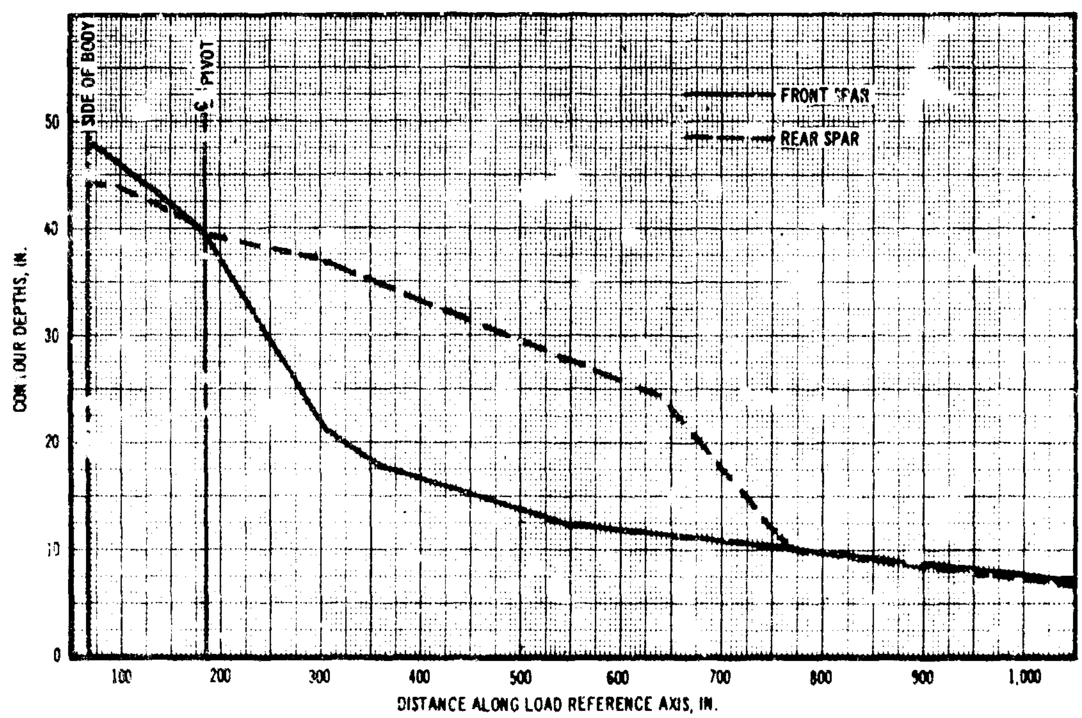


Figure 7-4. Wing Spar Depth

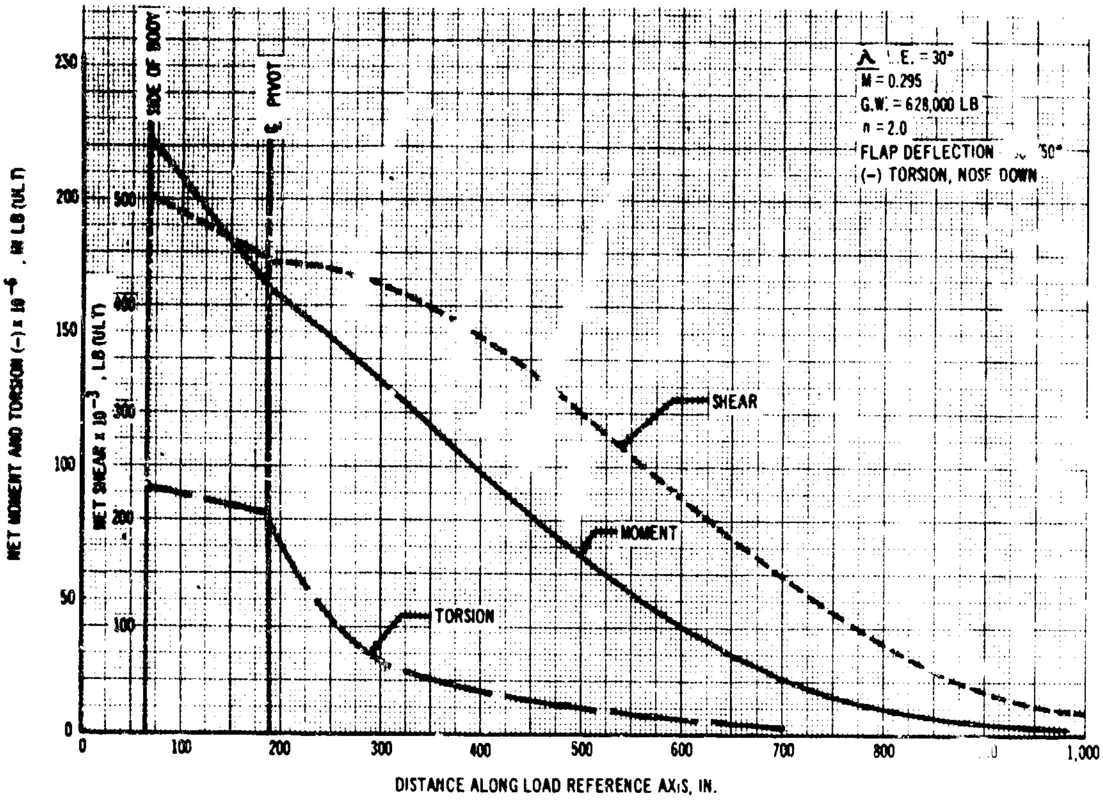


Figure 7-5. Ultimate Wing Loads, Flaps Down, Maneuver

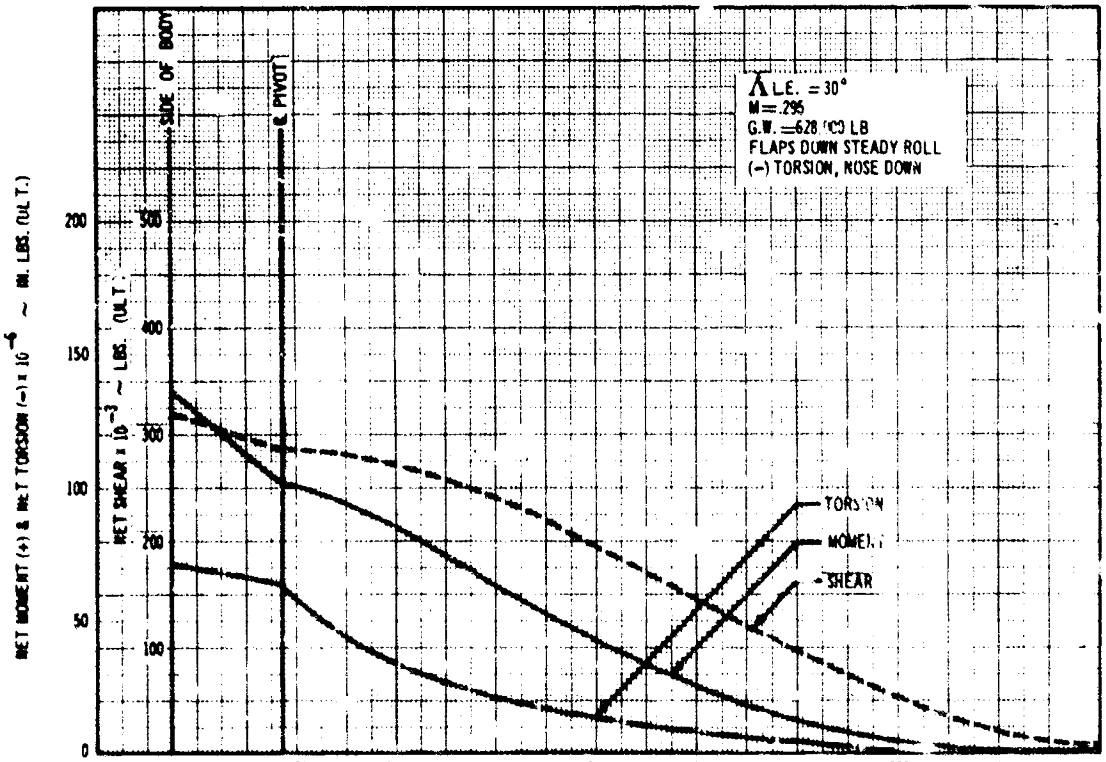


Figure 7-6. Ultimate Wing Loads, Flaps Down, Steady Roll

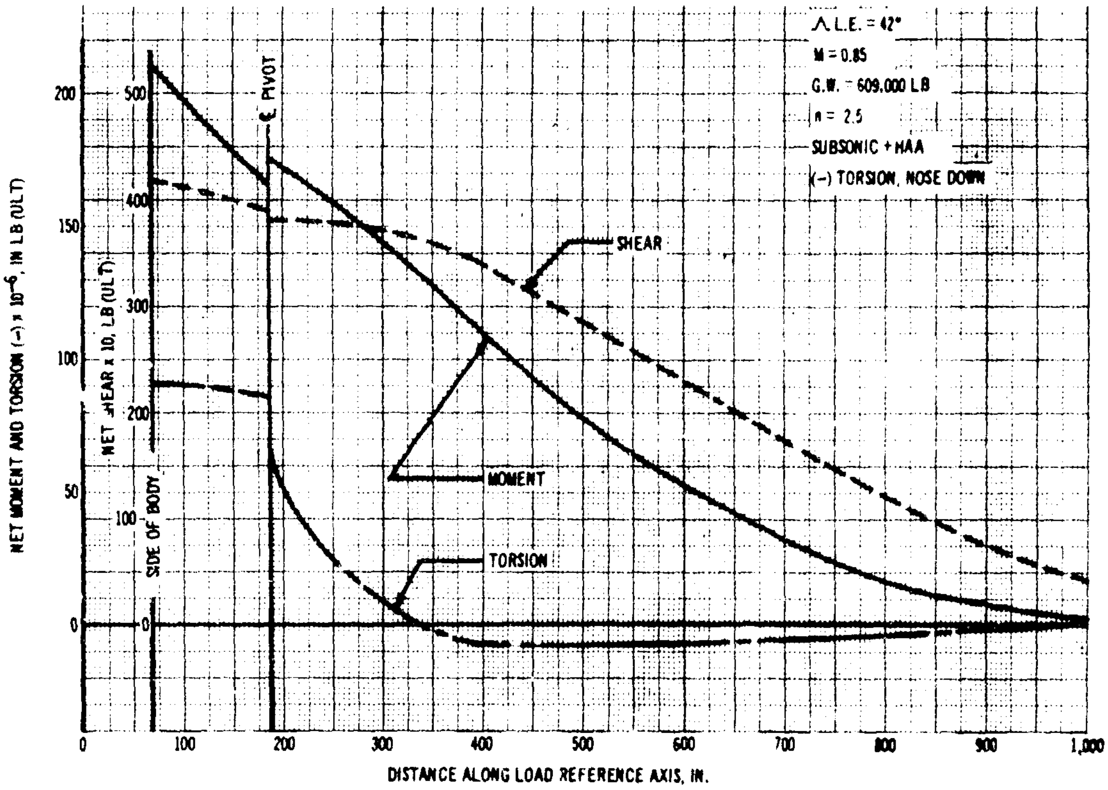


Figure 7–7. Ultimate Wing Loads, Subsonic Maneuver

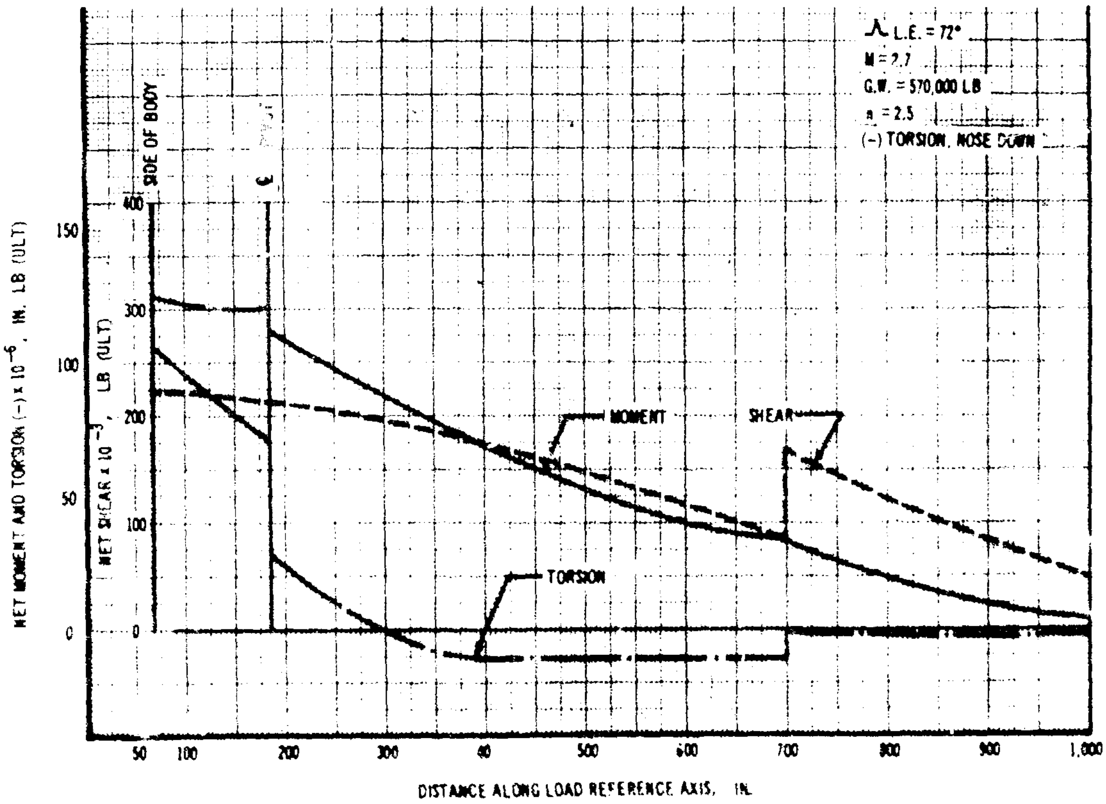


Figure 7–8. Ultimate Wing Loads, Supersonic Maneuver

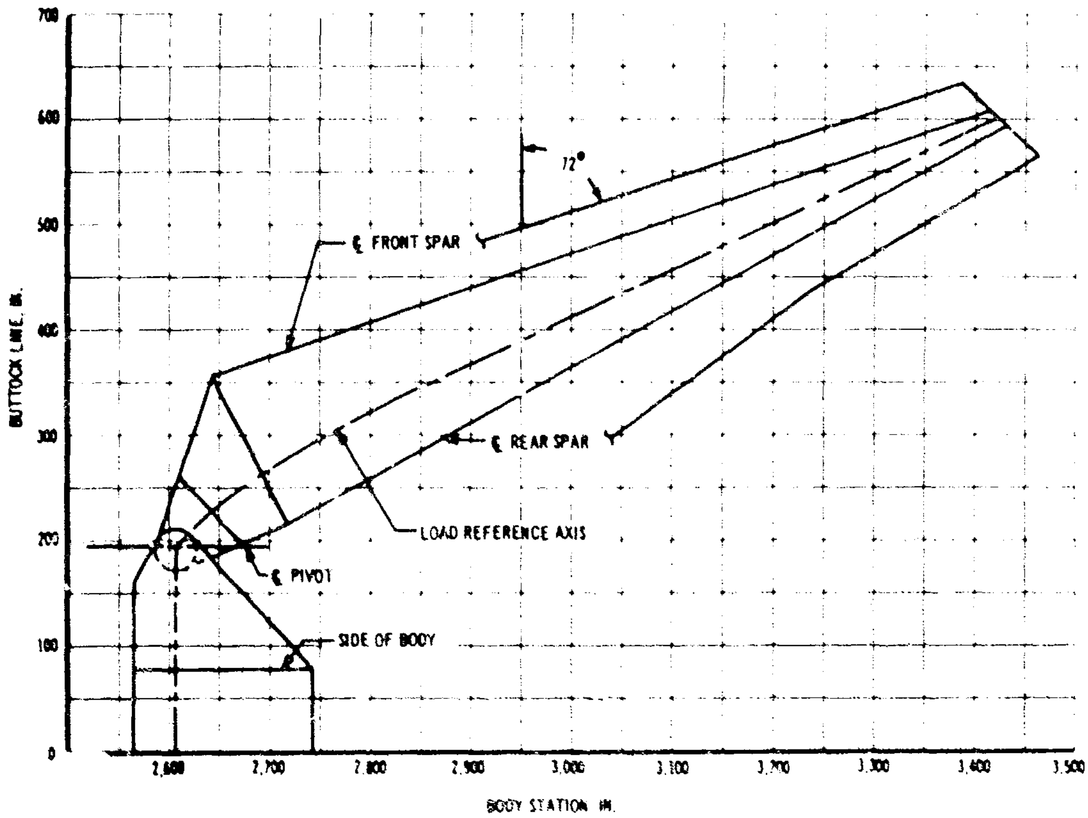


Figure 7–9. Load Reference Axis

7.2 Horizontal Tail. The structural diagram is shown in Airframe Design Report, V2-B2707-6-2, Fig. 3-2. The horizontal tail forms the aft portion of the total wing with the main wing swept to 72 deg. The airfoil of the tail is defined as part of the total wing tail airfoil with a thickness ratio of 2.85 percent at the side of body, providing adequate design for efficient skin stringer construction. Outboard of BL 375, the movable tip elevon has its own airfoil definition of 3 percent of the local chord. The tip elevon is hinged and operated by actuators located in a fairing on the upper surface.

The horizontal tail supports the engines, engine equipment, and fuel tank. The primary structure utilizes Ti 6Al-4V material.

The horizontal tail trailing edge is comprised of elevators with local area cutout to provide space for the engine thrust reverser.

7.2.1 Detail Weights

	Weight (lb)	
Horizontal Tail		
Total		20,300
Skin and stiffeners*	10,825	
Spar web and stiffeners*	1,050	
Interspar ribs*	1,250	
Forward fuel tank area (4.73 psf)	515	
Fixed leading edge (4.14 psf)	1,085	
Fence (B.S. 3041 to B.S. 3180) (2.59 psf)	85	
Tip elevon	2,215	
Elevon actuator fairing	205	
Elevators	1,760	
Fixed trailing edge (2.05 psf)	95	
Engine support provisions	680	
Access doors	65	
Non-optimum factor - 3.6% asterisk items	470	

7.2.2 Weight Determination Methods and Design Data. The primary structure is analyzed for strength by the same method as for the wing primary structure. Surface material is critical for a stiffness design for flutter prevention and control surface effectiveness Airframe Design Report V2-B2707-6-2, Sec. 4.

The weight of the control surfaces and secondary structure is based on drawings and is substantiated by comparison to statistical data on existing airplanes.

Area (exposed)	2,478 ft^2
Leading edge sweep	60 deg and 55 deg
Aspect ratio (exposed)	3.52
Taper ratio	0.15
Thickness ratio - Side of body (BL 67.5)	0.0285 (wing and tail)
BL 375	0.030 (tail only)
Tip	0.030 (tail only)
Dihedral angle (effective)	7 1/2 deg.
Control surface data	Table 7-C
Skin and stiffener area	Fig 7-10
Spar web and stiffener area	Fig 7-11
Average effective depth	Fig 7-12
Spar depths	Fig 7-13

See Airframe Design Report, V2-B2707-6-2, for the following:

Structural drawings	Figs 3-2 and 3-45 through 3-50
Design loads	Fig 4-51
Design allowables	Fig 4-7
Load reference axis	Fig 4-51

See Airframe Design Report, V2-B2707-7 for:

Speed Restrictions for Movable Surface	Table 2-A
Control surface areas	
Elevon	422 ft^2
Elevators - inboard auxiliary	149 ft^2
- primary	211 ft^2
- outboard auxiliary	111 ft^2

Minimum Gages	Skin	Stiffener	Honeycomb Face
Primary structure	0.030*	0.030	
Secondary structure	0.015	0.015	0.006

* 0.10, determined by stiffness requirements

Table 7-C. Contro. .urface Data

The following secondary horizontal ta.l structure weights are presented for comparison purposes. Variations result from differences in detail designs. These weights include actuation support.

Surface	Weight (lb)	Area (ft)	Unit (psf)	Existing airplane	Unit weight (psf)
Elevon	2,215	422	5.25		
Elevators	(1,760)	(471)	(3.74)	Boeing 720 B-52G	3.70 3.80
Inboard auxiliary	525	149	3.52		
Main	845	211	4.00		
Outboard auxiliary	390	111	3.51		

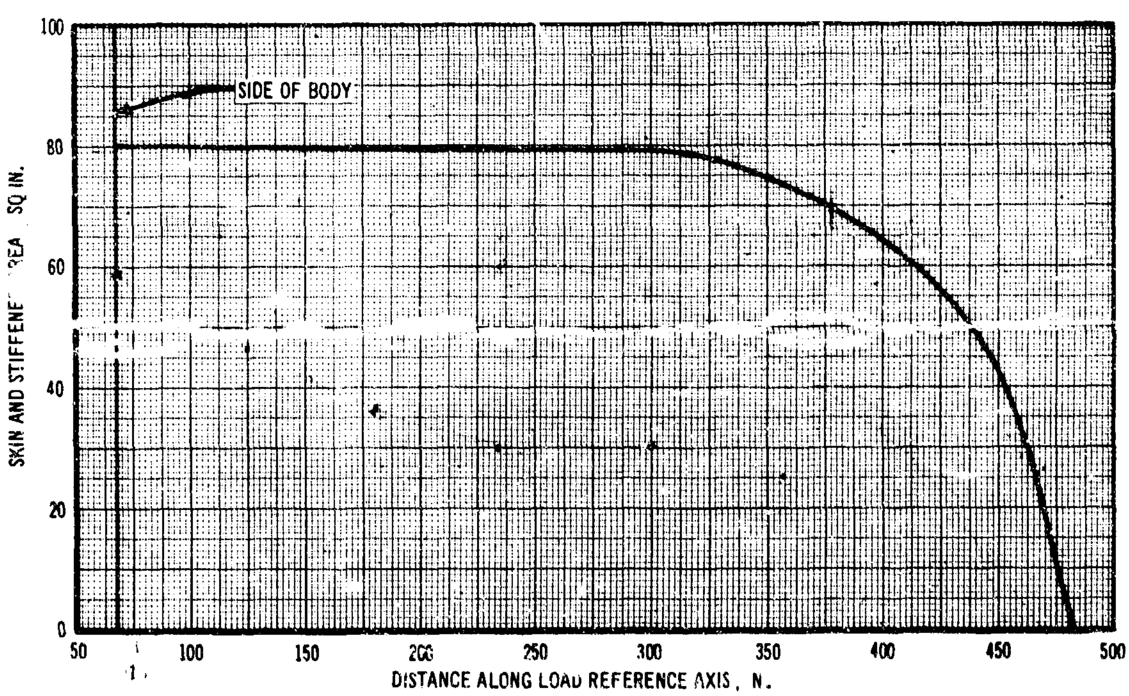


Figure 7-10. Horizontal Tail, Skin an.' Stiffener Area

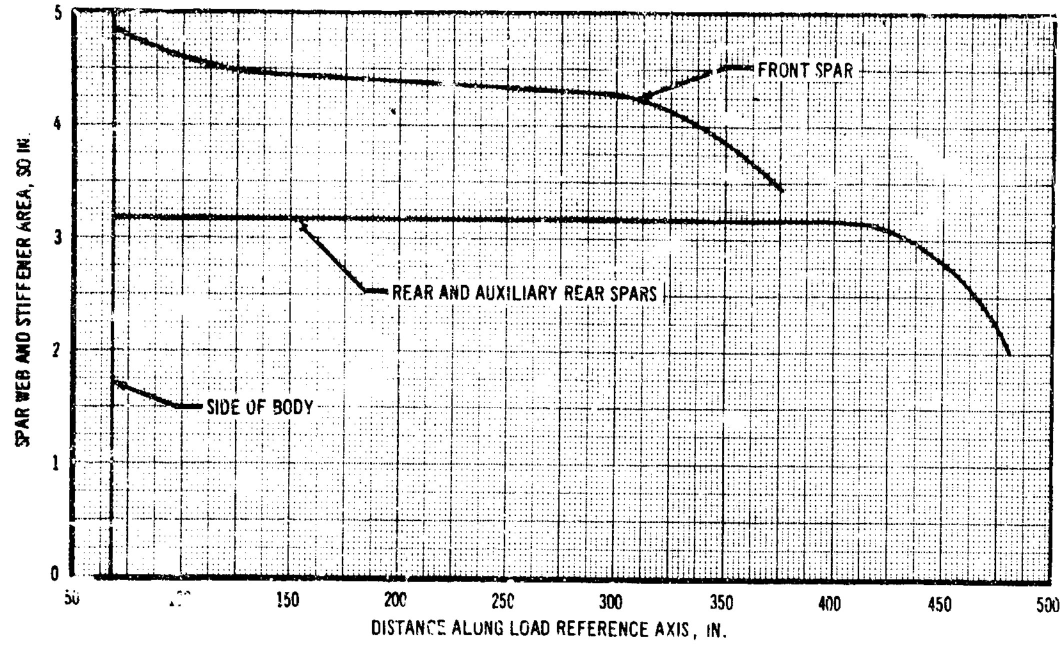


Figure 7–11. Horizontal Tail, Spar Web and Stiffener Area

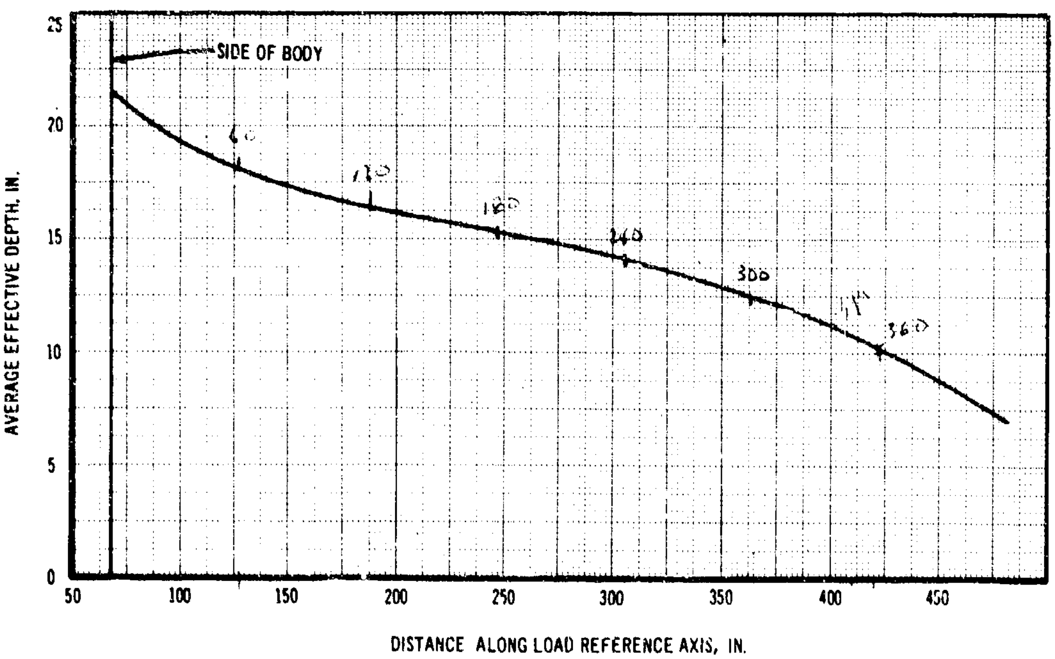


Figure 7–12. Horizontal Tail, Average Effective Depths

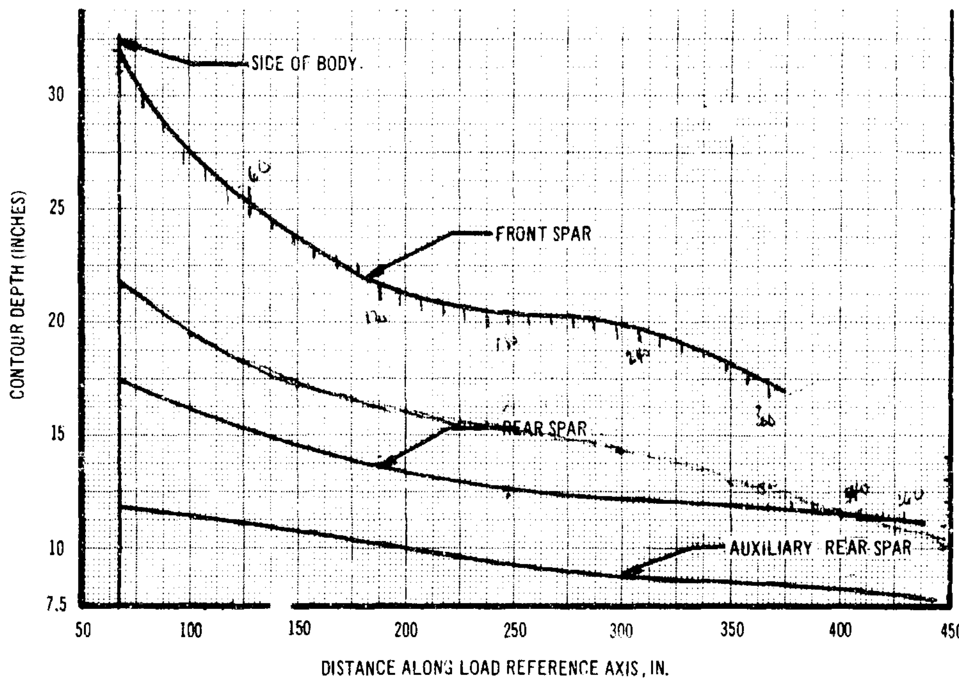


Figure 7–13. Horizontal Tail Depths

7.3 Vertical Tail. The vertical tail consists of a fixed fin and a rudder that is actuated from within the fin. See Airframe Design Report, V2-B2707-6-2, Fig. 3-51. The primary structure is Ti 6Al-4V skin-stringer construction with four spars. The secondary structure is bonded honeycomb panels with titanium skins and polyimide reinforced glass fabric core. The airfoil is a modified double wedge with maximum depth near the rear spar and rudder hinge.

7.3.1 Detail Weights

		Weight (lb)
Vertical Tail		
Total		5,000
Skin and stiffeners	1,600 — 1670 lbs	
Spar webs	210	
Ribs	306	
Joints and fasteners	212	
Joint, body tail	153	
Rudder, (3.15 psf)	904	
Rudder actuation supports	590	
Leading edge, (1.90 psf)	162	
Strake, (2.65 psf)	484	
Fixed trailing edge, (1.5 psf)	92	
Antenna provisions	25	
Tip (unit weight, 3.3 psf)	46	
Inspection doors	24	
Miscellaneous	192	

7.3.2 Weight Determination Methods and Design Data. The vertical tail bending material is determined by the same method as that used for the wing analysis. The remaining primary structure weight and all secondary structure weight are calculated from drawings. Detail analysis substantiates an efficient structure for the low-aspect-ratio vertical tail. The skin is shear-critical for torsion.

Area (fin)	875 sq ft
Area (rudder)	287 sq ft
Leading Edge Sweep	60 deg
Aspect Ratio	0.615
Taper Ratio	0.238
Thickness Ratio	0.03 at 70 percent chord
	0.025 at 30 percent chord

See Airframe Design Report, V2-B2707-6-2, for the following:

Vertical Tail Attachment Sturcture	Figs. 3-43 and 3-44
Structural Drawings	Figs. 3-51 thru 3-53
Allowables	Fig. 4-34
Design Loads	Figs. 4-56 and 4-57

See Aerodynamics Design Report, V2-B2707-3 for:

Rudder Speed Placard	Fig. 5-14

Minimum Gages	Skin	Stiffeners	Honeycomb Face
Primary Structure	0.030	0.030	N/A
Secondary Structure	N/A	N/A	0.006

7.4 Ventral. The ventral contains a tail skid to absorb landing ground loads which may occur. The lower edge is a replaceable nonmetal rub strip. See Airframe Design Report, V2-B2707-6-2, Fig. 3-51.

7.4.1 Detail Weights

		Weight (lb)
Ventral Fin		
Total		550
Leading edge, (1.88 psf)	25	
Trailing edge, (1.5 psf)	32	
Body attach	20	
Replaceable rub strip and supports	93	
Panels (1.15 and 0.96 psf)	225	
Bottom spar	11	
Antenna strip	13	
Spars	31	
Fairing	20	
Full-depth honeycomb bottom	55	
Miscellaneous	25	

7.4.2 Weight Determination Methods and Design Data. The weight of the ventral surface is based on calculations from drawings

See Airframe Design Report V2-B2707-6-2, for:

Structure Drawings	Fig. 3-51
Area	201 sq ft
Thickness Ratio (t/c)	3 percent at 29 to 66 percent chord
Minimum Gage, Honeycomb Face	0.006 in.

7.5 Body. Primary structure consists of skin and longitudinal stringers stabilized by ring frames. See Airframe Design Report, V2-B2707-6-2. Structural material is Ti 6Al-4V.

Body stiffness forward of the front spar is significantly improved from that of the 733-390 submitted in the Phase II-C interim report. The slenderness ratio (length/depth) has decreased from 16.2 to 14.4, thus reducing the dynamic landing ultimate factors.

The movable forebody has been lightened by reducing the window area and removing the translating visor. The double pivot feature is included in the weight.

Transverse floor beam structure is 120 lb lighter with the addition of vertical support posts at BL 50. This design concept is structurally more efficient than a cargo compartment without structural posts.

Intermediate frame depth of 3 in. and the circular lower lobe, result in decreased frame stresses. Corrugated webs have replaced the conventional flat web Z cross section. These revisions have increased the frame efficiency 25 percent.

There are longerons at the body side and wing lower surface intersection. These are continuous between the wing front spar and the aft pressure bulkhead. It is more efficient structurally to have continuous longerons rather than to redistribute shears into external keel chords at the body centerline.

The horizontal tail cutout allowance is eliminated with a fixed tail box center section.

7.5.1 Detailed Weights

		Weight (lb) GE	Weight (lb) P&WA
Body			
Total		47,100	47,020
Monocoque (skin and stringers)		18,760	
Longerons		2,010	
Frames		3,850	
Floors and Floor Supports		5,490	
Pressurized	2,300		
Unpressurized	3,190		
Bulkheads		4,240	
Fuel	2,610		
Spar (wing)	630		
Other	1,000		
Doors and Hatches (See Table 7-D.)		4,480	4,400
Main Gear Wheel Well		1,780	
Doors	1,180		
Station 2777 bulkhead	150		
Station 2837 bulkhead	100		
Station 2857 bulkhead	100		
Station 2917 bulkhead	100		
Station 2977 bulkhead	150		
Nose Gear Wheel Well		770	
Doors	252		
Longitudinal beam	342		
Skin pressure panels	284		
Drag brace and trunnion beams	45		
Shear ties	12		
Monocoque and frames removed	-165		
Movable Forebody		1,240	
Skin	262		
Frames	131		
Longerons	18		
Bulkheads	53		
Glass and sills	155		
Main actuator and attachments	283		
Forward pivot actuation	127		
Forward pivot structure	57		
Miscellaneous	154		

		Weight (lb) GE	P&WA
Windshield		630	
Posts and sills	155		
Glass	475		
Windows (152 including doors)		730	
Tear-Stopper Straps		670	
Tail Cone (Station 3544 aft)		600	
Wing-Body Attachment Fittings		300	
Seam Seal and Finish		180	
Production Joints		110	
Miscellaneous (3.9 percent of monocoque, frames, bulkheads, floors)		1,260	

7.5.2 Weight Determination Methods and Design Data. The weight of the monocoque is determined analytically as described in Phase IIA, Airframe Design Report, D6-8680-6, pages 126 and 150. A high confidence level is placed on the monocoque method because 14 conditions were analyzed to determine the loads envelope. Digital and/or analogue dynamic analyses are computed for dynamic landing and vertical gust. Refer to Airframe Design Report, V2-B2707-7, Pars. 3.2.3 and 3.2.4. The weight analysis for the taxi condition, using the static method, is conservative because it does not reflect the lower anticipated loads from the dynamic analysis (Par. 3.2.5 of the above reference).

The weights of other components are determined by detailed design and analysis. See the following figures.

Body Effective Depths, Vertical Conditions	Fig. 7-14
Body Effective Depths, Lateral Conditions	Fig. 7-15
Body Perimeter	Fig. 7-16
Body Beam Shear, Vertical Conditions	Fig. 7-17
Body Bending Moment, Vertical Conditions	Fig. 7-18
Body Beam Shear, Lateral Conditions	Fig. 7-19
Body Bending Moment and Torsion, Lateral Conditions	Fig. 7-20
Body Monocoque Section Area	Fig. 7-21
Body Monocoque Equivalent Gage	Fig. 7-22
Body Floor Width and Area	Fig. 7-23
Body Door Sizes	Table 7-D

See Airframe Design Report, V2-B2707-6-2, for:

Fuselage Structure Diagram	Fig. 3-25
Forebody General Arrangement	Fig. 3-26
Wheel Well Fuselage Frame	Fig. 3-30
Intermediate Fuel Bulkhead	Fig. 3-36

Floor Structure	Fig. 3-38
Passenger Window	Fig. 3-39
Passenger Door	Fig. 3-40
Cargo Door	Fig. 3-41
Wing Center Section to Fuselage Attachment	Fig. 3-42
Fin-Spar Pressure Bulkhead	Fig. 3-43
Fin-Spar Fuel Bulkhead	Fig. 3-44
Allowable Stresses	Figs. 4-33 thru 4-35

See Airframe Design Report, V2-B2707-7, for:

Fuselage Airload Distribution	Figs. 3-10 thru 3-12
Forward Fuselage Bending Moment Distribution	Fig. 3-30
Envelope of Forward Fuselage Bending Moments and Shears Due to Landing Impact	Figs. 3-45 and 3-46
Effect of Taxi Speed on Vertical Acceleration	Fig. 3-57
Fuselage Design Conditions	Table 3-C

Body Minimum Gages	Skin	Stringer	Honeycomb Face
Primary Structure	0.032	0.025	—
Secondary Structure	0.016	0.020	0.006

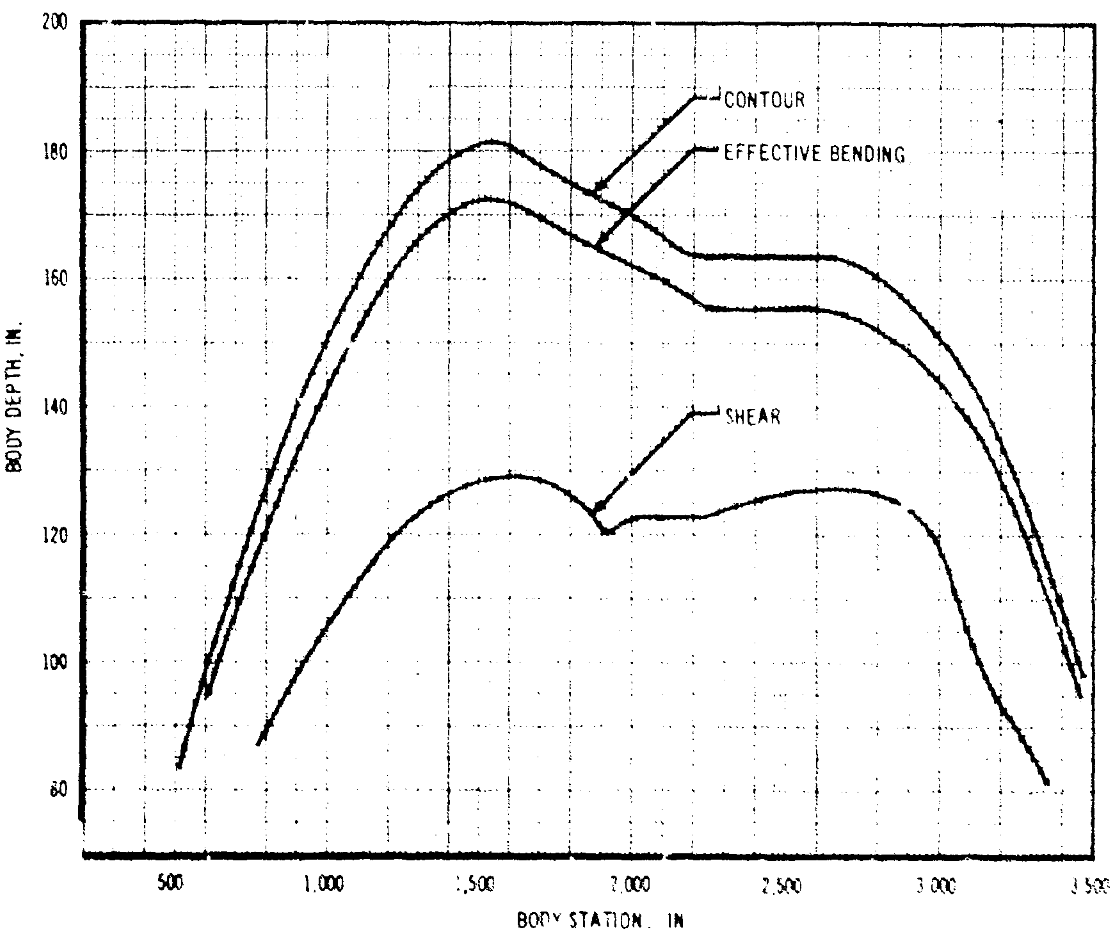


Figure 7-14. Body Effective Depths, Vertical Conditions

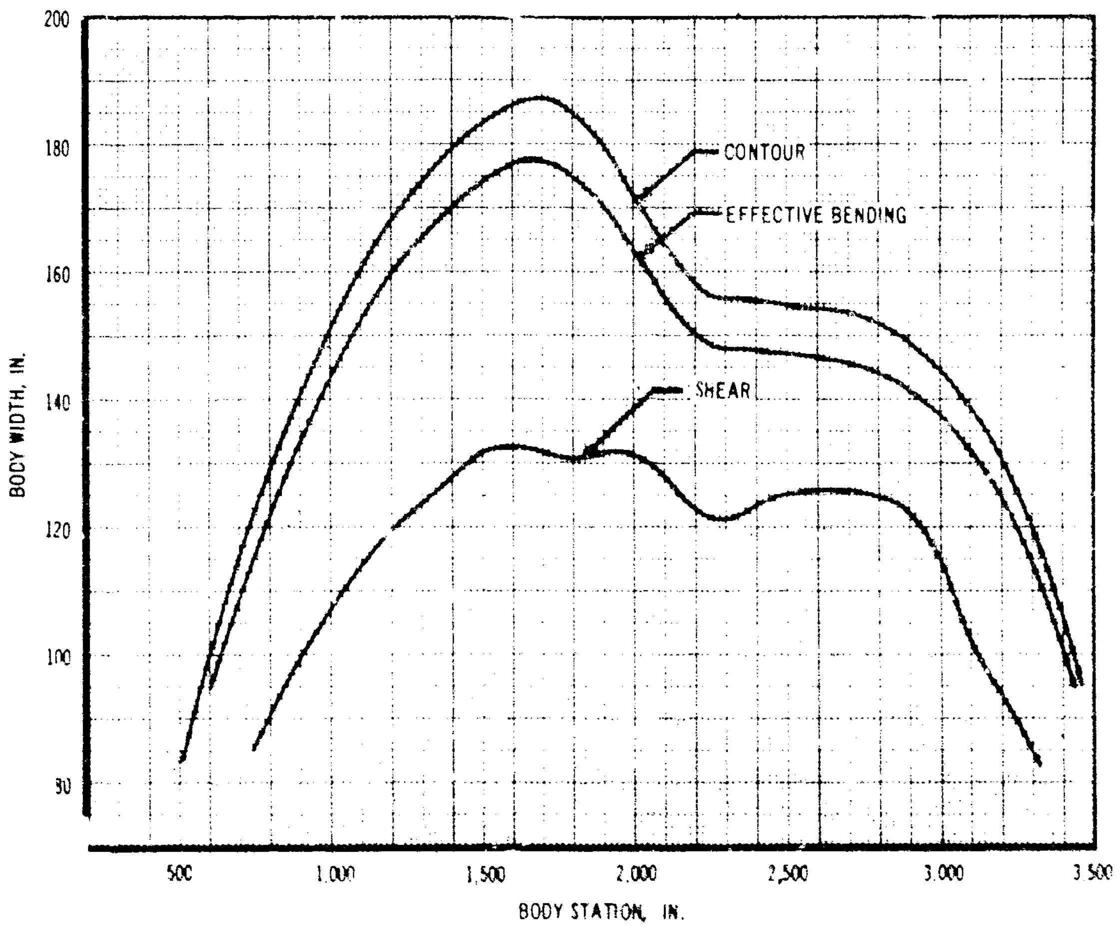


Figure 7-15. Body Effective Depths, Lateral Conditions

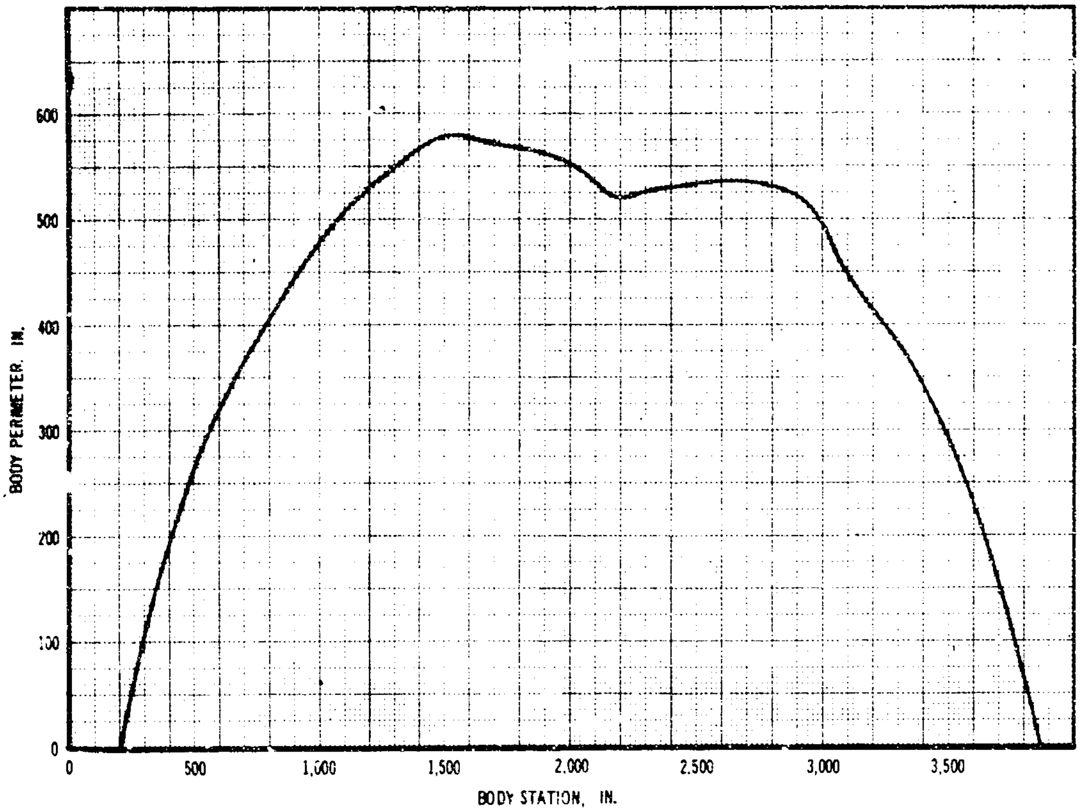


Figure 7-16. Body Perimeter

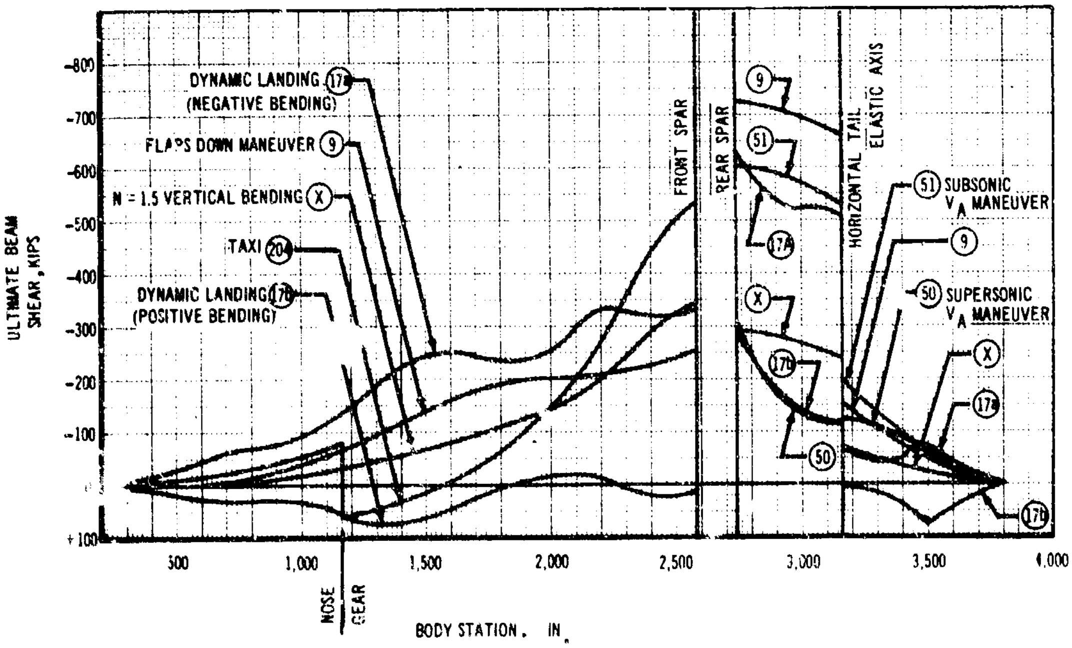


Figure 7-17. Body Beam Shear, Vertical Conditions

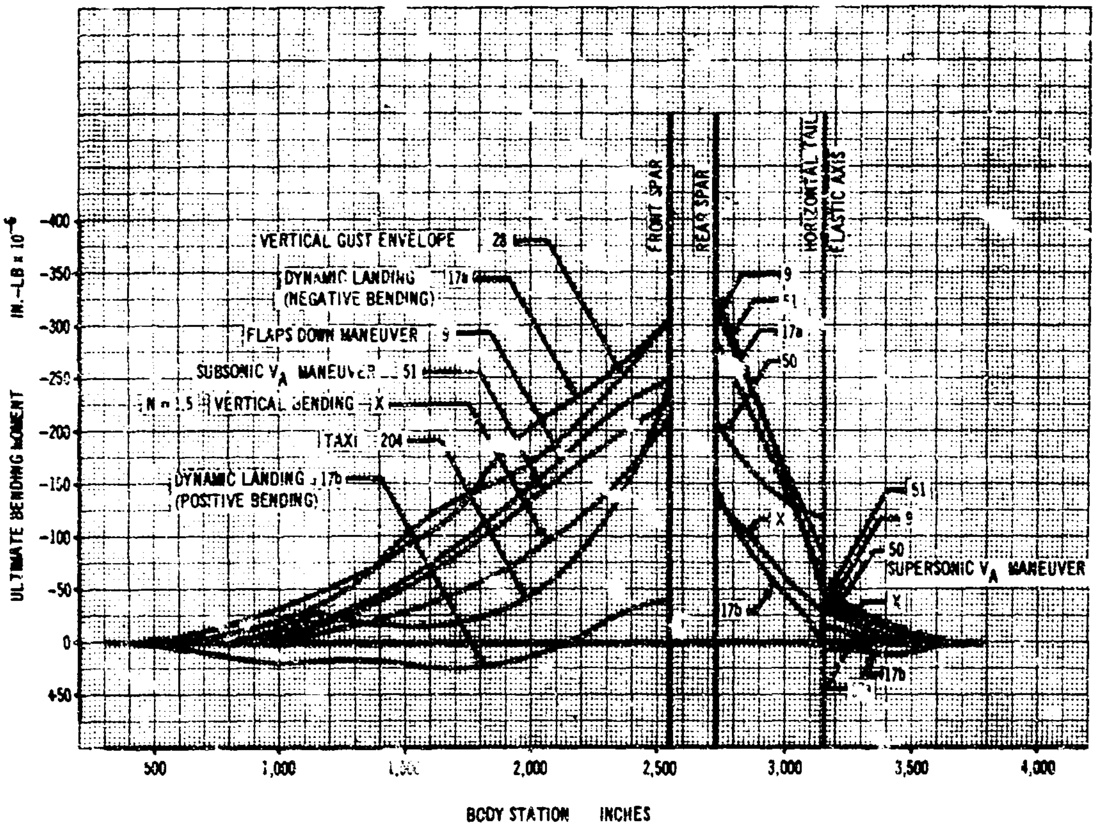


Figure 7-18. Body Bending Moment, Vertical Conditions

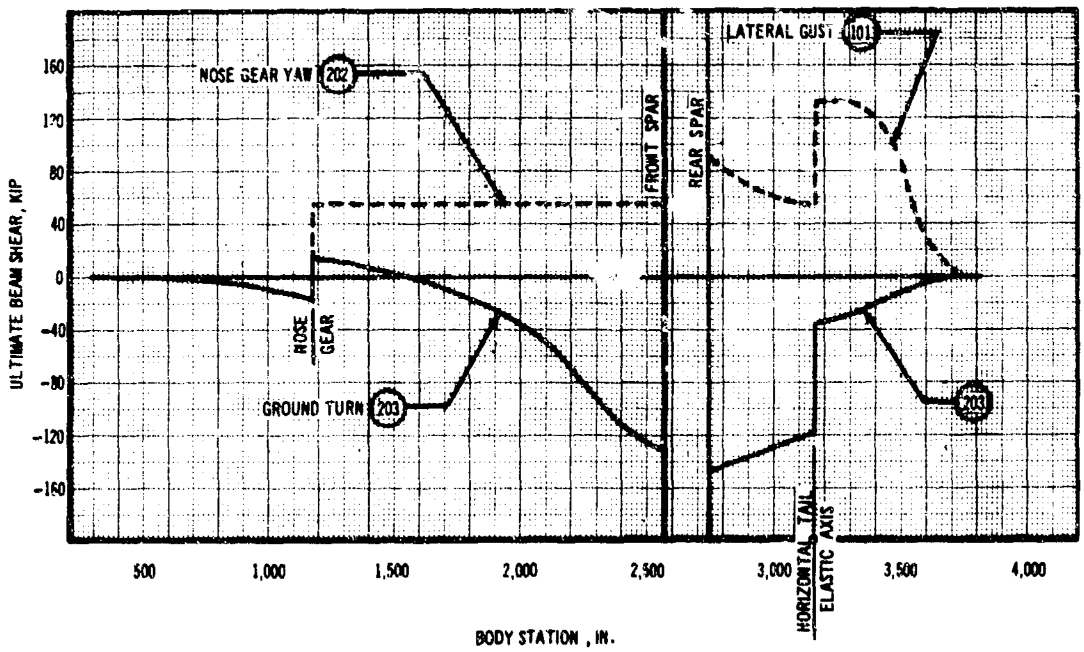


Figure 7-19. Body Beam Shear, Lateral Conditions

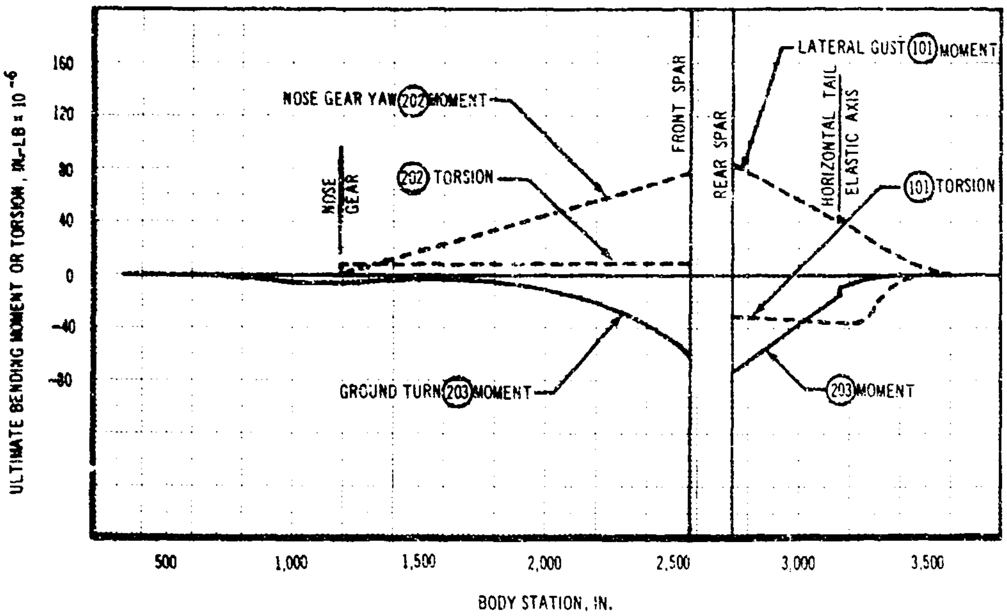


Figure 7-20. Body Bending Moment and Torsion, Lateral Condition

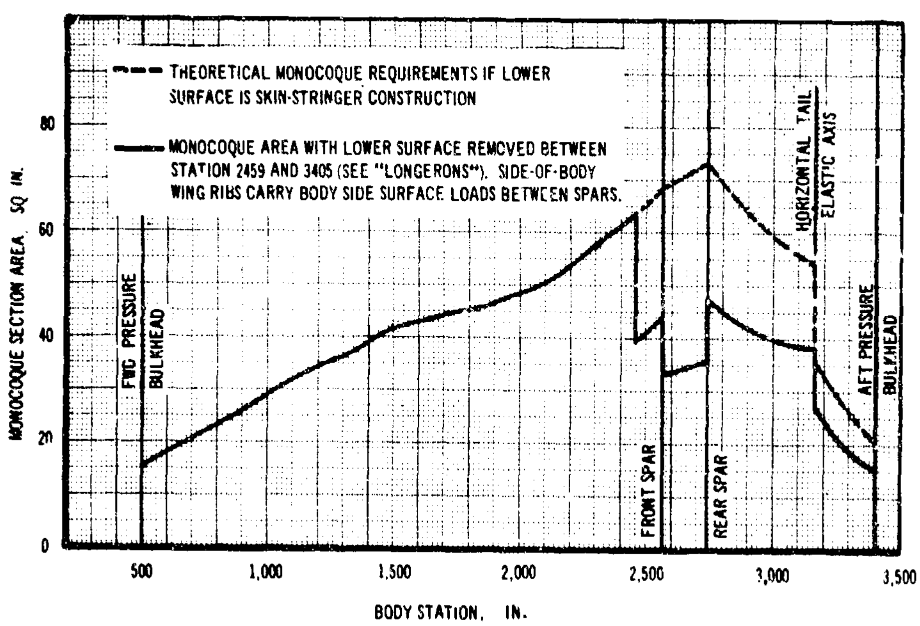


Figure 7-21. Body Monocoque Section Area

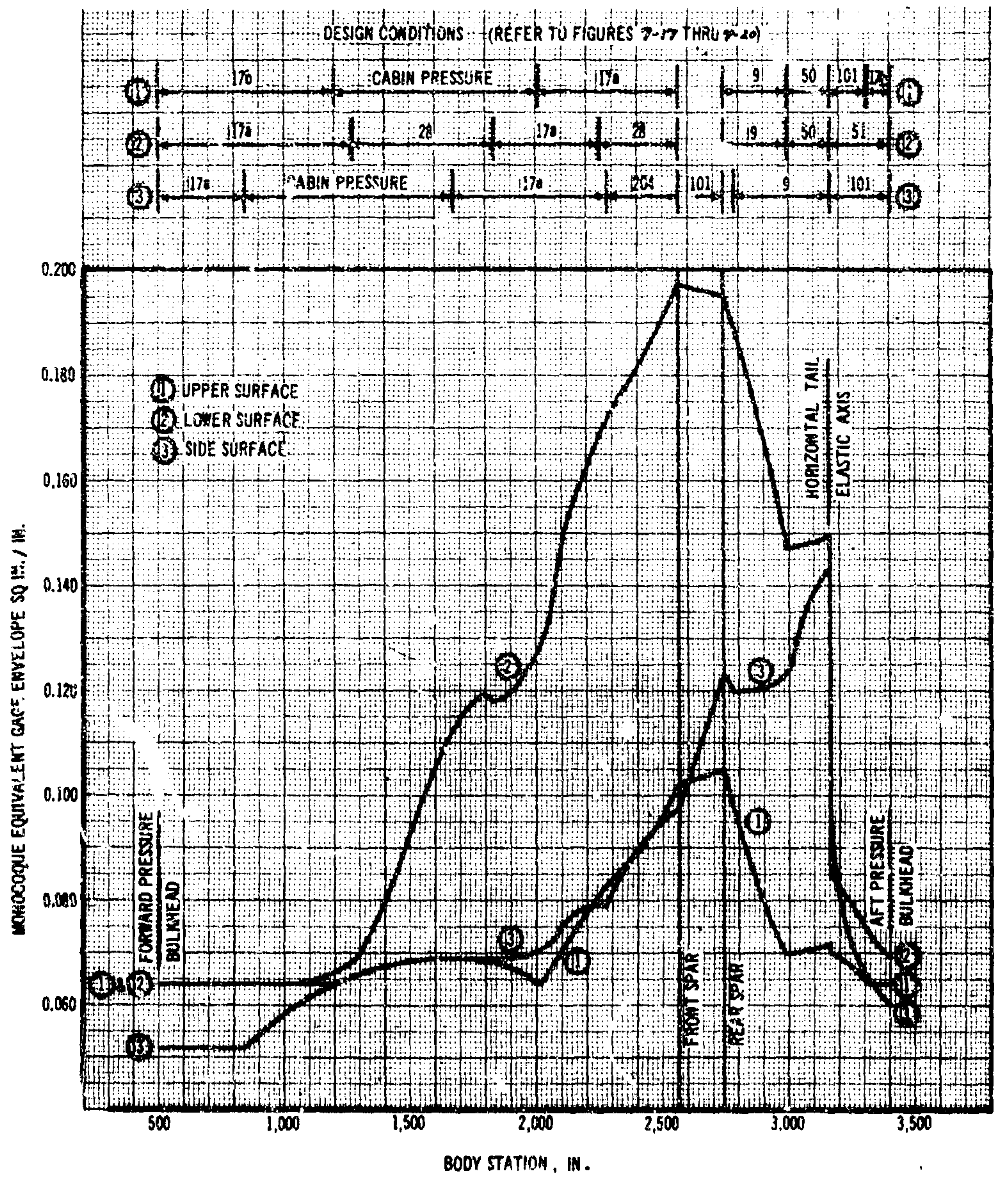


Figure 7–22. Body Monocoque Equivalent Gage

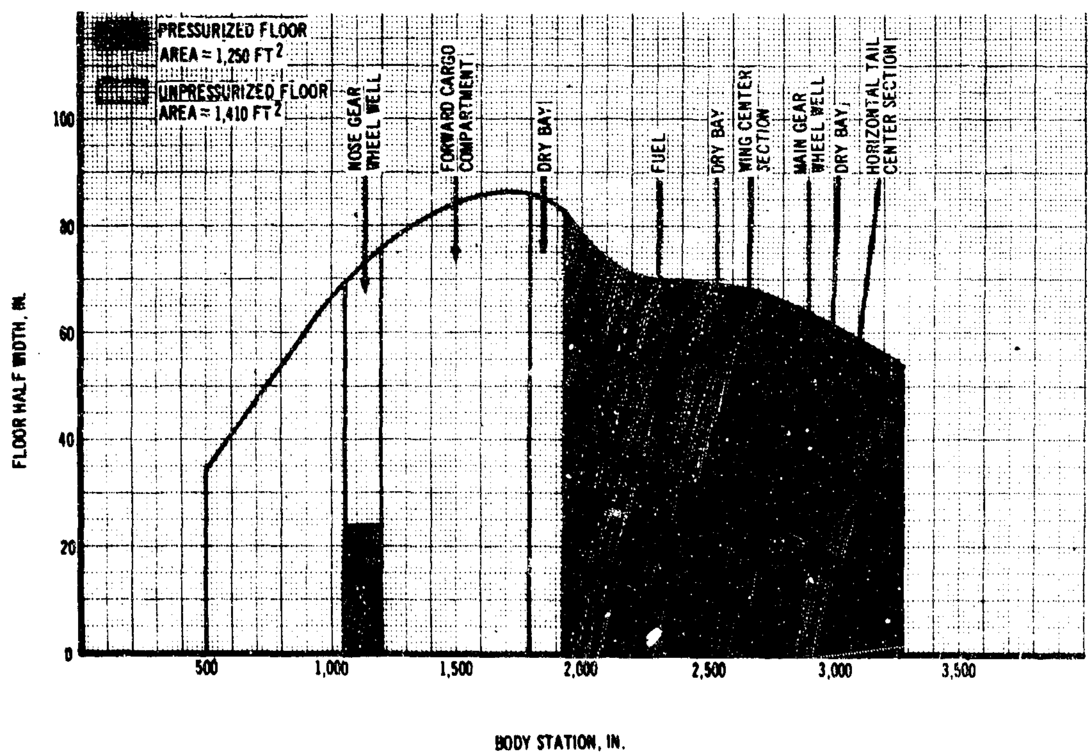


Figure 7-23. Body Floor Width and Area

Table 7-D. Body Door Sizes

Door	Body Station	No.	Size	Area (Projected)
Units	in.		in. x in.	sq ft
Crew escape (left hand)	590	1	19 x 20	2.6
Crew escaps (centerline)	632	1	19 x 20	2.6
Forward entry (left hand)	817	1	32 x 72	16.0
Forward galley (right hand)	846	1	32 x 60	13.3
Forward cargo (centerline)	1411	1	50 x 100	34.7
Midentry (left hand)	1542	1	42 x 72	21.0
Midgalley (right hand)	1542	1	42 x 60	17.5
Class I emer. escape (left hand)	2291	1	42 x 72	21.0
Class I emer. escape (right hand)	2291	1	42 x 60	17.5
Class II emer. escape (left and right hand)	2619	2	20 x 44	12.2
Class I emer. escape (left hand)	2961	1	32 x 72	16.0
Aft galley (right hand)	2961	1	32 x 60	13.3
Aft cargo (centerline)	3318	1	50 x 100	34.7
Miscellaneous access	—	—	—	—
Fuel access	—	9	13 x 20	16.3
Ram air turbine (GE only)	2841	1	48 x 36	12.0

7.6 Main Landing Gear. A four-post main landing gear configuration is installed. See Airframe Design Report, V2-B2707-6-2. This concept provides maximum runway flotation with minimum weight and stowage space. Each gear consists of conventional four wheel trucks. Major structural components are made of 4340M (vacuum remelt) steel heat treat to 270 ksi minimum.

The forward gears are outboard, attached to the front spar of the wing box in the area of the wing pivot and retract forward into the wing strake. The aft gears are steerable, attached to the rear spar of the wing box, and retract aft into the lower body.

The two gears on each side of the airplane are load equalized by means of a hydraulic manifold system. The manifold may be locked out for static conditions.

7.6.1 Detail Weights

	Quantity	Weight (lb) Forward Gear	Weight (lb) Aft Gear	
Main Landing Gear				
Total				25,500
Wheels	16	880	880	
Tires	16	1,486	1,486	
Air		64	64	
Brakes	16	1,604	1,604	
Shock strut assembly		2,560	2,5[illegible]0	
Fluid-oleo		135	200	
Truck assembly		914	914	
Drag struts		270	360	
Side struts		310	400	
Torsion links		318	340	
Support structure		1,550	1,490	
Retraction system		1,190	1,540	
Manifold system		150	150	
Brake system		353	353	
Steering system		—	1,050	
Extension system, emergency		—	150	
Miscellaneous		71	84	

7.6.2 Weight Determination Methods and Design Data. The weight of the rolling gear components is based on supplier data. Structure component weights are calculated using critical loads and include allowances for lugs, fittings, and assembly parts. Weights of systems are estimated based on similar existing systems and calculations for actuators and plumbing components.

Maximum Design Taxi Weight	635,000 lb
Length (trunnion to static ground line)	
Forward gear	160.6 in.
Aft gear	156.35 in.
Tires*	(16) 45 x 19.2 Type VIII, 26 Ply Rating
Stroke	
Forward gear	16 in.
Aft gear	40 in.
Manifold stroke	
Forward gear	6 in.
Aft gear	6 in.
Tire static Load	37,600 lb @ 170 psi and 32% deflection
Brake Energy Requirements	
Refused takeoff	31.6 (10^6) ft-lb/Brake
Normal braking condition	21.9 (10^6) ft-lb/Brake

See Airframe Design Report, V2-B2707-6-2, for:

Structural Drawings	Figs. 3-55 and 3-56
Main Landing Gear Ultimate Reactions	Tables 4-F and 4-G
Section Areas	Fig. 4-67 and 4-68

See Airframe Design Report, V2-B2707-7, for:

Ultimate Ground Loads	Table 3-I Table 3-J

* Tire size is satisfactory for the 675,000 lb gross weight.

7.7 Nose Landing Gear. The nose landing gear is a single-strut two-wheel steerable configuration which retracts forward into the body. See Airframe Design Report, V2-B2707-6-2, Fig. 3-54. Major structural components are made of 4340 M (vacuum remelt) steel to a minimum heat treat of 270 ksi.

7.7.1 Detail Weights

	Quantity	Weight (lb)	
Nose Landing Gear			
Total			1,500
Wheels	2	95	
Tires	2	180	
Air		9	
Shock strut assembly		628	
Fluid-oleo		35	
Struts and links		185	
Torsion links		45	
Retraction system		128	
Steering system		156	
Extension system, emergency		16	
Miscellaneous		23	

7.7.2 Weight Determination Methods and Design Data. The weight of the rolling gear components is based on supplier data. Structural components weights are calculated using critical load data and reflect allowances for lugs, fittings, and assembly parts. System weights are based on comparable components and calculations for actuators and plumbing.

Maximum Design Taxi Weight	635,000 lb
Length (trunnion ℄ to static ground line)	109.5 in.
Tires*	(2) 34 x 16 Type VIII, 26 ply rating
Tire static load	22,600 lb at 160 psi and 32% deflection
Stroke	18 in.

See Airframe Design Report - Part B, V2-B2707-6-2, for:

Ultimate Reactions	Table 4-E
Section Areas	Fig 4-66
Structural Drawing	Fig 3-54

See Airframe Design Report Part C, V2-B2707-7, for:
Ultimate Ground Loads Table 3-I and 3-J.

* Tire size is satisfactory for the 675,000 lb gross weight.

7.8 Nacelle. The nacelle group consists of the engine inlet and the engine installation components which include the engine cowl panels. A structural diagram of the engine inlet is shown in Propulsion Report, V2-B2707-12. A structural diagram of the engine cowl panels is shown in Propulsion Report, V2-B2707-13. The primary nacelle material is Ti 6Al-4V.

A mixed compression axisymmetric inlet with a strut-supported variable-diameter centerbody for throat area control is incorporated in the design. The inlet cowl includes a system of pressure-operated vortex valves to augment and amplify throat bleed, and a set of doors on the aft portion for bypass and takeoff air control.

The inlet weight includes a control system for automatic operation. Cockpit controls and indicators allow manual positioning of the centerbody and bypass doors.

An independent, engine-mounted hydraulic system provides power for centerbody and bypass actuation.

The engine cowl provides access to the engine and its mounting, plumbing, and wiring. It consists of three removable panels with small access doors for service functions.

The forward engine flange supports the inlet, and the engine mounting system is designed to support the inlet, engine, and exhaust system.

7.8.1 Detail Weights.

	Quantity	Weight (lb) GE	Weight (lb) P&WA
Nacelle	4		
Total		(12,300)	(12,900)
Inlet	4	8,280	9,940
Centerbody	4	2,080	2,480
Struts	16	520	640
Cowl and doors	4	3,380	4,160
Diverter	4	180	200
Actuation	4	940	1,160
Controls	4	280	280
Hydraulics	4	700	780
Miscellaneous	4	200	240
Engine Installation	4	4,020	2,960
Engine cowl panels	12	1,300	900
Aft engine cowl	4	600	
Mounting strut	4	90	80
Engine mounts	8	960	920
Wing attach fittings	8	670	670
Firewall and seals	4	260	250
Miscellaneous	4	140	140

7.8.2 Weight Determination Methods and Design Data. The weight of the nacelle structural components is calculated from detailed design drawings.

Inlet hydraulic and control systems weights are based on system diagrams and supplier weights of components.

Minimum Gage	Skin	Frames
Inlet	0.030	0.035
Cowl	0.010	0.025
Engine	**GE4/J5P**	**PWA JTF 17A-21B**
Airflow (sea level static)	620 lb/sec	687 lb/sec
Inlet Capture area	3,040 sq in.	3,580 sq in.
Engine cowl panel area	278 sq ft	178 sq ft

See Propulsion Report V2-B2707-12 for:

Inlet Cowl Structure		Fig. 6-4
Inlet Centerbody Structure		Fig. 6-5
Hydraulic System Diagram		Fig. 6-8
Control System Diagram		Fig. 6-9

See Propulsion Report V2-B2707-13 for:

Engine Mount System	(GE)	Fig. 5-28
	(P&WA)	Fig. 5-29
Engine Cowl Panel Structure	(GE)	Fig. 5-30
	(P&WA)	Fig. 5-32
Aft Engine Cowl	(GE)	Fig. 5-31

7.9 Engine Weight. The weight of the GE4/J5P engine at 620-lb/sec airflow is 11,125 lb as specified in GE letter, E. E. Hood, Jr. to M. L. Pennell, July 15, 1966.

The weight of the PWA JTF 17A-21B engine at 687-lb/sec airflow is 10,450 lb as specified in P&WA preliminary draft, specification No. 2710, June 28, 1966. See Propulsion Report V2-B2707-12 and V2-B2707-14.

7.9.1 Detail Weights.

11,125

	Quantity	Weight (lb) GE	Weight (lb) P&WA
Engine	4)	44,500	41,800
		41,500	

* Ref V2-B2707 -12

Addendum Part A Pg. 9

G.E. * 11237 lb

P&WA 10,640

7.10 Engine Accessories - Accessory Drive System. The accessory system provides a means of transmitting power between the engines and the following accessories:

a. Starters

b. Air-Conditioning Compressors

c. Generators

d. Hydraulic pumps

The drive units and connected accessories for the inboard engines are located in the body while the units for the outboard engines are located in the outboard leading edge area of the horizontal tail. The bays and lubricating oil are temperature-conditioned with exhaust air from the cabin intrawall system. An oil-to-air compartmented heat exchanger serves three individual lubricating and cooling oil systems, generator, compressor, and accessory drive gear box. A 60-lb/min, 2.5-hp blower ensures sufficient cooling airflow through the heat exchanger. For further details, see System Report, V2-B2707-11, Sec. 9.0

The engine drain system is provided by both engine manufacturers and is not included in the airframe manufacturers weight.

7.10.1 Detail Weights

	Quantity	Weight (lb) GE	Weight (lb) P&WA
Engine Accessories — Accessory Drive System			
Total		(1,100)	(1,160)
Gear box	4	565.6	
Shaft and angle drive	4	140.0	200.0
Coupler	4	100.0	
Electric interlock			
Engine gearbox decoupler	4	12.0	
Hydraulic pump pad adapters	8	18.4	
Starter pad adapter	4	10.8	
Compressor pad adapter	4	16.6	
Generator pad adapter	4	14.9	
Heat exchanger	4	100.0	
Blower	4	40.0	
Electric wiring and associated circuitry		56.0	
Supports		25.7	

7.10.2 Weight Determination Methods and Design Data. The weights of the accessory drive gear box, electric interlock, and accessory pads are based on Sundstrand Engineering Proposal 1935A-P10. The coupler is similar to that

described in the Hamilton Standard Proposal EP 66322, Vol. II, May 24, 1966. Heat exchanger and blower weights are derived from statistical data. Estimated weights of wire and electrical components are based on experience gained in other programs.

Rpm Range	4,000 to 8,000 rpm
Maximum Output Loads	
Item	Horsepower
Hydraulic pump	134
Air compressor	134
Generator	350
Starter input torque	980 ft-lb

7.11 Engine Controls. One cable loop is required from the control levers to the engine for thrust control, thrust reverser, and autothrust control operation. A second cable loop to each engine provides mode selection. See Propulsion Report, V2-B2707-12, Sec. 4, for engine controls description. Signal fidelity in cable transmission is maintained by a tension regulator installed in each loop. Each tension regulator also serves as, or replaces the forward quadrant of the respective loop. Large-diameter pulleys reduce pilot effort in cable movement. This system also includes two autothrottle servos and four noback thrust control clutches.

7.11.1 Detail Weights.

	Quantity	Weight
Engine Controls		
Total		(300)
Cables, terminals, and turnbuckles		83
Pulleys and supports	64	128
Idler and supports	160	16
Cable tension regulators	8	19
Quadrants	8	8
Mechanism through firewall to engine	8	12
Autothrottle components		
Throttle servos	2	8
Clutch racks	4	24
Supports		2

7.11.2 Weight Determination Methods and Design Data. The autothrottle servos and clutch rack weights are supplier quotations. Cable installation, idler pulleys, and tension regulator weights are catalog items. Pulley weights are estimated from a layout of a titanium honeycomb lightweight pulley.

Rod, shaft, and crank weights at the firewall and engine areas are based on similar installations of current jet aircraft.

Pilot effort (maximum design)	(75 lb) (lever radius) = in. lb	
Thrust system angular displacement at engine	120 deg	

	GE	P&WA	
Critical positions at engine thrust	5	4	throttle
	4	3	mode
Independent autothrottle servoclutch	1/engine		

For engine control system diagram, see Propulsion Report, V2-B2707-12, Fig. 4-72.

7.12 Starting System. The starting system is described in Systems Report, V2-B2707-11, Sec. 8.0.

7.12.1 Detail Weights.

	Quantity	Weight GE	Weight P&WA
Starting System			
Total		(400)	(430)
Starters	4	204	
Shutoff valves, crossfeed line	3	20	
Check valves, crossfeed line	5	20	
Shutoff valves, start control	4	31	
Ducting, fittings, and supports	-	31	111
Ground cart receptacle installation	1	17	
Wire and supports	-	27	
Engine bleed control valves +		24	

7.12.2 Weight Determination Methods and Design Data. The turbine starter and control valve weights are obtained from Garrett Corporation Report PT7213R, June 6, 1966. Ducting weight is calculated from drawings.

Ducting Design Conditions

Start of cruise

System operating on crossbleed at 1,100°F and 90 psia with the engine disconnected and the starter driving the accessory drive unit.

Starter

Designed for continuous duty

7.13 Fuel System. The fuel system for the B-2707 reflects the following significant features:

a. Direct tank to engine feed

b. Use of fuel from tanks until empty

c. No fuel transfer required to remain within flight cg limits

d. Reserve equally distributed among main tanks

e. No fuel tank inerting required

f. Uses present day commercial aviation kerosene

g. Unpressurized fuel vent system

The system includes four main tanks and four auxiliary tanks. The system is described in Airframe Design Report, V2-B2707-13, Sec. 2.0.

7.13.1 Detail Weights.

	Quantity		Weight (lb) GE	Weight (lb) P&WA
Fuel System				
Total			(7,000)	(7,010)
Forward Body Fuel Tanks			1,013	
Bladder cells	9	260		
Backing board		331		
Interconnects and fittings		194		
Vapor sealant		143		
Access doors	9	40		
Hangers and supports		45		
Strake Fuel Tanks			172	
Sealant		162		
Check valves		10		
Outboard Wing Fuel Tanks			563	
Insulation		220		
Sealant		333		
Check valves		10		
Integral Tank Inboard Wing and Wing Center Section			344	
Insulation		129		
Sealant		211		
Check valves		4		
Integral Tanks, Horizontal Tail and Tail Center Section			1,055	
Insulation		712		
Sealant		336		
Check valves		7		

	Quantity	Weights (lb) GE		P&WA
Tail Cone Tank, Bladder and Integral			348	
Bladder cells	3	61		
Backing board		133		
Interconnects and fittings		28		
Vapor sealant		39		
Access doors	3	14		
Hangers and supports		15		
Sealant		58		
Engine Fuel Feed System			1,631	1,641
Main boost pumps	8	144		
Auxiliary override pumps	11	165		
Pump installations		360		
Valves and supports		254		
Tubing		432		442
Fittings and supports		276		
Pressure Refueling System			430	
Valves and fueling station		125		
Tubing		188		
Fittings and supports		117		
Fuel Dump System			263	
Valves and supports		58		
Tubing		121		
Fittings and supports		84		
Fuel Crossfeed System			18	
Valves and supports		8		
Tubing		7		
Fittings and supports		3		
Vent System			951	
Tubing		509		
Sumps and exits		74		
Fittings and supports		318		
Sealant		50		
Electrical			212	
Wire		170		
Supports and connectors		29		
Switches, relays, etc.		13		

7.13.2 Weight Determination Methods and Design Data. The weights of the fuel system components are determined from studies, layouts, and from supplier weights. Fuel pump weights are supplied by Thompson-Ramo-Wooldridge Company. The weights of the bladder cells are based on unit weights of cell

material and fittings provided by Goodyear. Interconnect and vent fittings are based on KC-135 data. Tubing and hose weights are based on lengths and diameters scaled from drawings.

Fitting and support weights are estimated as a percentage of tubing weight. A density of 10 lb/cu ft is used for the foam insulation. (See Airframe Design Report, V2-B2707-8, Par. 3.0.)

Tank Capacities

Tank	Volume (U.S. gal)	Weight (6.7 lb/gal)
Main No. 1	4,150	27,800
Main No. 2	4,150	27,800
Main No. 3	4,150	27,800
Main No. 4	4,150	27,800
Forward Auxiliary	20,450	137,000
Aft Auxiliary	3,820	25,600*
Auxiliary No. 1A	7,530	50,450
Auxiliary No. 4A	7,530	50,450
Total	55,930	374,700

*The aft auxiliary tank carries 2,680 gal (18,000 lb) of flight fuel with the additional volume available for adjusting the fuel cg.

Tank Construction

Forward body tanks	Bladder Cells, Flexible
Tail cone tanks	Bladder Cells, Flexible
Tail cone tank	Integral
Wing center section	Integral, Bottom Insulated
Outboard wing	Integral, Bottom Insulated
Inboard wing	Integral, Bottom and Top Insulated
Strake	Integral
Horizontal tail	Integral, Bottom and Exposed Top Insulated

Flow Rates

Pressure fueling	2,000 gal/min
Engine feed	105,000 pounds per engine per hour
Dumping	8,500 lb/min

Maximum Operating Pressure 50 psi

Proof Pressures

Engine fuel feed system	195 psi
Engine fuel feed tubing	260 psi
Fueling and dump systems	240 psi

Tubing Material

Inside fuel tanks	Aluminum
Outside fuel tanks	Titanium and Aluminum

See Propulsion Report, V2-B2707-13, for the following diagrams:

System Diagram	Fig. 2-6
Tank Arrangement Diagram	Fig. 2-7

7.14 Instruments. Instruments and displays are described in Systems Report, V2-B2707-11, Sec. 6.0.

7.14.1 Weight Determination Methods and Design Data. Actual weights or supplier data are used. Wire weights are calculated from drawings and diagrams. Approximately 400 lb of wiring are included in the instrument weight.

Instruments, displays, and associated electronic weights are grouped according to function where possible.

7.14.2 Detail Weights.

	Quantity	Weight (lb)	
Instruments			
Total			(1,250)
Navigation Instruments			90
Air Data Instruments			160
Angle of Attack Warning and Control System			13
Engine Instruments			340
Oil systems, quantity, temperature, and pressure	12	54	
Engine thrust meters	4	70	
Engine vibration indicators	4	28	
Engine rpm indicators	4	20	
Engine inlet instruments		124	
Engine nozzle instruments		42	
Engine trim control indicators	4	2	
Generator Instruments			16
Fuel System			136
General			185
Surface control position		95	
Air conditioning		31	
Starter manifold pressure	1	4	
Water system	1	3	
Hydraulic system		52	
Annunciators			35
Warning light assemblies			30
Aircraft Integrated Data System provisions			100
Miscellaneous Instruments			145

7.15 Surface Controls and Hydraulics. The surface control and hydraulic systems are interrelated and the descriptions of these systems are combined. See Systems Report, V2-B2707-11, Sec. 4.0.

Hydraulic power is supplied by three main hydraulic systems, a standby system, and a ram air turbine-powered system. The three main hydraulic systems (system A, B, and C) are the source of normal control surface power. The C system provides the power for landing gear extension, retraction, steering, door operation, and normal braking. System B supplies power to a hydraulic motor-driven pump in the standby system. The standby system serves the following purposes:

a. Standby power for the brake system

b. Power for aft gear steering and braking during towing

c. Standby release of all gears and extension of aft main gear.

The ram air turbine-powered hydraulic system provides power for flight surfaces during an all-engine-out condition. It is required only if the General Electric engines are used.

Longitudinal, directional, and lateral control surfaces are operated by one or more cylinder-type actuators.

Wing and inboard and outboard trailing edge wing flaps are positioned by ball screw actuators which are driven by torque tubes from gear boxes. The gear boxes are each driven by three hydraulic motors. Each motor is energized by a separate main hydraulic system. Leading edge strake, and wing slats, and the engine deflector flaps are operated in the same manner except that their gear boxes have two motors each. All surfaces in each of these installations can be controlled through their full range at a reduced rate with one motor functioning.

Cable tension regulators improve manual valve control resolution. Pilot effort is maintained at suitable levels with the installation of large diameter pulleys where there is a change in direction of control cables.

A full range of pilot authority is available through the electric command system in the lateral and longitudinal direction. The pilot may select either autopilot or electric command for these axes.

Surveillance of control by the stability augmentation system is continuous in all three axes.

Longitudinal trim is accomplished by either electrical or mechanical control of the hydraulic servos. Directional and lateral trim is accomplished by electrical control only.

Control signals are programed as required by various mechanical installations. Master and SAS servos are used to amplify and implement signals to actuator valves.

7.15.1 Detail Weights.

	Quantity		Weight (lb) GE	Weight (lb) P&WA
Surface Controls				
Total			(10,600)	(10,150)
Cockpit Controls			90	90
Control column and supports	2	30		
Rudder pedal installation	4	60		
Autopilot, Electronic Command, Autothrottle, and Stability Augmentation System			350	350
Components excluding servos		130		
Wire and associated circuitry		220		
Wing Sweep Actuation and Programer			2,850	2,850
Wing sweep drive system and supports	1	453		
Wing sweep actuator and supports	2	2,300		
Hydraulic tubing, fittings, and supports		30		
Hydraulic fluid		40		
Mechanical asymmetry system	1	12		
Programer		15		
Cable Control of Wing Sweep Flap and Slat			60	60
Cables, idlers, pulleys and supports		45		
Tension regulators (cable)		15		
Wing and Strake Leading Edge Devices			925	925
Drive system gearb x and motors	2	40		
Drive train to actuators	2	290		
Actuators and supports	36	560		
Hydraulic tubing, fittings, and supports		16		
Hydraulic fluid		3		
Asymmetry systems	2	16		

	Quantity		Weight (lb) GE	Weight (lb) P&WA
Wing and Strake Trailing Edge Devices			1,375	1,375
Drive system gear box and motors	3	190		
Drive train to actuators and supports	3	288		
Actuators and supports	12	600		
Slaved linkage	6	120		
Hydraulic tubing, valves, fittings, and supports		142		
Hydraulic fluid		11		
Asymmetry systems	3	24		
Primary Flight Control Cable Installation			371	371
Cables, idlers, pulleys, and supports		315		
Cable tension regulators and quadrants		56		
Flight Control Programing Components			260	260
Master servos, roll and pitch	2	50		
Trim servos	3	10		
SAS servos	3	60		
Programers, pitch, and roll	2	60		
Feel and centering mechanisms	3	20		
Lockout mechanisms	3	18		
Speed brake mechanisms	1	11		
Trim negator	1	16		
Travel limiter, rudder		15		
Wing Spoilers			670	670
Actuators, valves and supports	12	415		
Hydraulic tubing and supports		135		
Hydraulic fluid		120		
Ailerons			155	155
Actuators, valves, and supports	2	120		
Hydraulic tubing and supports		22		
Hydraulic fluid		13		
Elevons			1,130	886
Power package, valves, cylinders, etc.	2	400		
Linkage		480		
Actuator supports		80		
Hydraulic tubing and supports		90		
Hydraulic fluid		80		

	Quantity		Weight (lb) GE	P&WA
Primary Elevators			1,366	1,160
Power assembly, valves, cylinders, etc.	2	846		
Linkage	18	280		74
Actuator assembly supports		80		
Hydraulic tubing and supports		90		
Hydraulic fluid		70		
Auxiliary Elevators			298	298
Power package, valves, cylinders, etc.	4	160		
Actuators assembly supports		30		
Hydraulic tubing and supports		60		
Hydraulic fluid		48		
Rudder			600	600
Power package, valves, cylinders, etc.	1	470		
Actuator assembly supports		80		
Hydraulic tubing and supports		30		
Hydraulic fluid		20		
Electric Wire and Associated Circuitry			100	100
Hydraulic System				
Total			(3,600)	(3,420)
Engine-Driven Pump Systems	3		3,225	3,225
Pumps 125 gpm	8	520		
Pump disconnect	8	16		
Pressure discharge modular packages	3	285		
Return line modular packages	3	144		
Case drain filters	8	8		
Heat exchangers, fluid-to-fuel	6	70		
Heat exchangers, fluid-to-ram air	3	75		
Ducts door actuators and supports for air heat exchanger		160		
Reservoirs, for 3-pump system (boot strap)	2	190		
Reservoir, for 2-pump system (boot strap)	1	125		
Pump ripple dampers	6	90		
Warmup modular packages	3	18		
Fire shutoff valves	6	18		
Temperature control modular package	3	10		
Reservoir pressurization and regulatory system	3	8		
Basic hydraulic system component supports		30		

	Quantity		Weight (lb) GE	P&WA
Tubing, pressure lines		344		
Tubing, supply lines		70		
Tubing, return lines		180		
Fluid in components		163		
Fluid in tubing		465		
Wing pivot swivels		50		
Tube joints and fittings		75		
Line valves		10		
Tubing-clamps, supports and manifolds		40		
Hose, hose connections, and flexes		40		
Wire and associated circuitry		21		
Standby Hydraulic System			195	195
Electric-driven pump	1	26		
Hydraulic motor-driven pump	1	15		
Reservoir, boot-strap type	1	35		
Pressure, modular package	1	20		
Return, modular package	1	15		
Standby hydraulic system component supports		15		
Tubing, pressure lines		14		
Tubing, supply lines		4		
Tubing, return lines		10		
Gear-operated control valve and installation	1	4		
Tubing, pneumatic lines		1		
Fluid in standby system components		6		
Fluid in tubing		16		
Tubing joints, fittings, flexes, and hoses		1		
Tubing clamps and supports		1		
Line valves		1		
Wire and associated circuitry		11		
All-Engine Out System			180	None
Ram-air-driven turbine	1	55		
Hydraulic pump		65		
Door control actuator (internal lock)		13		
Swivel valve		5		
Shutoff valve (door-operated)		3		
Valve (door-controlled)		2		
Ram air turbine component supports		9		
Tubing, pressure lines		5		
Tubing, supply lines		5		
Tubing actuator		5		
Fluid in ram air turbine system components		1		
Fluid tubing		9		
Tubing joints, fittings, flexes, and hoses		1		
Line valves		1		
Wire and associated circuitry		1		

V2-B2707-6-1

7.15.2 Weight Determination Methods and Design Data. Supplier weight estimates of the proposed pumps, turbine, motors, and filters are the basis for weights used in this proposal.

The weight of modular packages, reservoirs, and associated installation parts were estimated from layouts. The weight of valves, ripple dampers, and heat exchangers were obtained from various manufacturers' catalogues. Tubing, fittings, and fluid weights are based on system diagrams.

Autopilot, auto throttle, electric command, and stability augmentation system weights reflect supplier quotations.

Power unit weights previously quoted by suppliers in response to specified requirements for particular control surfaces have been projected to establish the weight of current units.

Some ball screw actuators, cable tension regulators, motors, etc. are estimated with the aid of manufacturers' catalogs. The weight of large, well-defined installations such as the wing sweep actuation system is estimated from layouts.

Master servos, programers, and mechanical control signal transmission items that are used on current jet airplanes provide a base for similar B-2707 component weights.

Hydraulic System	No. of Pumps	Pumps Flow Rate
Main system A	3	125 gpm
B	3	125 gpm
C	2	125 gpm
Standby system		
Electric-driven	1	6 gpm
Hydraulic-motor-driven	1	24 gpm
Turbine-powered system	1	135 gpm

Pressure	3,000 psi
Fluid-to-fuel heat exchangers	6 units
Fluid-to air heat exchangers	3 units
Hydraulic fluid	Boeing Material Specification 3-10
Normal operating temperature	+60°F to +350°F
Environmental temperature	-50°F to +400°F
Pressure and return lines	Ti 6Al-4V
Hydraulic bay location	Between Body Stations 2381 and 3041

See Systems Report V2-B2707-11, for the following:

Item	Par. or Fig. No.
Hydraulic System Diagram	Fig. 4-55
Schematic-Longitudinal, Lateral and Directional Control Systems	Fig. 4-2
Longitudinal Control System Diagram	Fig. 4-30
Lateral-Directional Control System Block Diagram	Fig. 4-31
Schematic LE Slats, Wing Sweep, TE Flaps and Speed Brake Control Systems	Fig. 4-12
Description of Warm-up Loop	Sec. 4
Description of Ram Air Turbine Extension System	Sec. 4

7.16 Electrical System. The generating system consists of four 60-kva variable speed-constant frequency (VSCF) channels and a stanby battery-powered system. The power distribution center is located in a bay behind the aft passenger cabin bulkhead, as shown in Systems Report, V2-B2707-10.

7.16.1 Detail Weights.

	Quantity	Weight (lb)		
Electrical System				
Total				3,600
Electrical Power System			1,970	
60-kva VSCF generator	4	464		
Oil and cooling, generator	4	52		
Control unit, generator	4	34		
Frequency changer	4	140		
Filter	4	150		
Current transformer assembly, load differential protection	4	6		
Generator circuit breaker	4	16		
Bus tie breaker	4	16		
Synchronizing bus tie breaker	2	8		
Load circuit breaker	4	2		
AC switched bus circuit breaker	2	1		
AC switched bus transformer relay	2	6		
28 v ac transformer	6	18		
28 v ac switched bus transformer	2	6		
Switched bus differential current transformer assembly	6 6	6		
Forward bus differential current transformer assembly	4	4		
Switched bus differential protection unit	2	2		
Forward bus differential protection unit	2	2		
Generator control panel	1	9		
Auxiliary control panel	1	6		
Meters and warning devices		5		
Generator and load circuit breaker boxes	8	23		
Generator feeder wire		85		
Forward bus feeder wire		133		

	Quantity	Weight (lb)	
Forward switched bus feeder wire		104	
Bus wiring		150	
Generator control wire		34	
Differential protection unit wire		4	
Meters and warning devices wire		3	
External power contactor	2	10	
Ground service bus contactor	1	5	
External power receptacle	2	3	
Ground service bus receptacle	1	2	
External power and bus protection control	2	6	
28 v ac ground service bus transformer	3	9	
External power differential current transformer assembly	8	8	
External power wire		100	
Transformer rectifier	6	54	
Transformer rectifier circuit breaker	6	3	
DC Switched bus circuit breaker	2	1	
Standby power circuit breaker	4	2	
Battery (5 amp hr)	1	15	
Energy storage device (39 amp hr)	1	50	
Standby power control assembly	1	40	
Transformer rectifier control wire		1	
Battery control wire		1	
Cooling provisions		27	
Equipment rack		144	
Electrical Distribution System			1,630
Grounding studs and terminal studs		45	
Panels and boxes		96	
Remote circuit breakers	137	26	
Forward circuit breakers	676	127	
Relays	66	38	
Remote circuit breaker control wire		162	
Receptacles, connectors, and plugs		164	
Transformers		54	
Control cabin lights		55	
Passenger cabin lights		234	
Work and maintenance lights		76	
Landing and taxi lights		33	
Flight and navigation lights		48	
Wiring		302	
Raceways, conduit, and wire support		170	

7.16.2 Weight Determination Methods and Design Data. The generating system weights were taken from Vol. II, General Electric proposal, May 16, 1966. Weights of the remaining equipment are based on similar items used on present airplanes or are estimated. Wire weights for all power circuits are based on current flow and allowable voltage drops. Low power level circuit weights are based on prorating similar circuits of present day airplanes.

Wiring. The wire is primarily nickel-plated copper with teflon insulation, except for heavy power feeders in pressurized areas (which are teflon-insulated aluminum), and engine-mounted wire. (See Zone C requirements.) Requirements are divided into three zones:

Zone A is the pressurized area with a temperature range of -40° to +160°F. The type of wire used in this area is either molded multiconductor cable or conventional bundled cables meeting the requirements of MS 18114 and MIL-W-22759. Aluminum wire is used for heavy power feeders.

Zone B is the unpressurized area, other than engine areas, with a temperature range of -65°F to +450°F. Wire used in this area is similar to MS 18001 as defined by XBMS-13-32. This wire is encased in rigid or flexible conduit in exposed areas such as wheel wells and between movable surfaces such as the wing pivot.

Zone C is the unpressurized engine area with a temperature range of -40°F to +1000°F. The engine-mounted wire is metal jacketed as defined by XBMS 13-33. MIL-W-7139B wire encased in flexible conduit is used between the engine and the fire wall.

Generator. Variable speed-constant frequency, heat rejection, 9.8 kw per generator at full load, maximum ambient temperature 300°F (constant) or 375°F for 5-min duration, oil-cooled, brushless.

Frequency Converter-Filter. 60-kva, heat rejection 3.0 kw per channel at full load.

Major Electrical Loads

Item	Connected Load kva
Fuel pumps (19)	138.0
Galleys (6)	60.0
Electronics	5.8
Interior lights	15.0
DC Supply	7.2
Exterior lights	9.2
Pitot heaters	2.5
Windshield heat	7.7
Blowers	14.3
Brake cooling	14.0
Nose actuator	6.0
Standby hydraulic pump	10.0
Water heater and toilet	5.5
Miscellaneous	10.0

Note. The duty cycle of the connected loads varies during airplane operating conditions so the system operates at nominal generator capacity without overload.

7.17 Electronics. The electronics group is designed for traffic and operation procedures projected for the 1970 time period. Dual communication radios, dual radio aids to navigation, and triple inertial navigational systems provide reliability and safety. See Communications Navigation Subsystem Specification, D6A10122-1.

7.17.1 Detail Weights.

	Quantity	Weight (lb)		
Electronics				
Total				2,320
Communications System				
HF Communications			326.5	
Transceiver	2	110		
Control panel	1	1.5		
Antenna coupler	2	40		
Coupler control	2	16		
Vertical fin antenna	1	75		
Ventral fin antenna	1	20		
Coax cable (410 ft)		64		
VHF Communications			52.5	
Transceiver	2	27		
Blade antenna	2	13.5		
Panels	2	6		
Coax cable (36 ft)		6		
Passenger Address System			224	
Amplifier	2	20		
Speaker, 8-in.	60	96		
Speaker, 4-in.	11	17.7		
Control panel	1	0.8		
Music tape recorder	1	23		
Speaker cover and pan	71	65.5		
Chime	1	1		
Interphone System			34.4	
Amplifier	1	1.3		
Audio selector panel	4	6		
Cockpit speaker	2	3		
Handsets	5	7		
Hanger, handsets	5	1.5		
Boom mikes and headsets	4	5.6		
Audio control center	1	10		
Selective Call System			12.6	
Decoder	1	10.3		
Control	1	1.3		
Chime	1	1		

	Quantity	Weight (lb)	
Navigational Equipment			
ATC Transponder			37.8
Transponder	2	28	
Control	1	2	
Antenna	2	3	
Coax (20 ft)		4.8	
Inertial System			172
Navigation units	3	75	
Display panel	3	12	
Control panel	3	4	
Converter unit	2	40	
Switching unit	1	15	
Battery	3	18	
Detector, magnetic azimuth	2	4	
Compensator, compass	2	4	
Weather Radar System			107
Transmitter-receiver	1	42	
Display indicator	2	30	
Control unit	2	4	
Antenna	1	28	
Wave guide	1	3	
Radio Altimeter			40
Receiver-transmitter	2	22	
Antenna	4	4	
Coax (90 ft)		14	
Low-Frequency ADF			73.8
Receiver	2	21.2	
Control panel	2	3.6	
Antenna assembly, loop/sense	2	46	
Coax (30 ft)		3	
VHF Navigation			149
VOR/LOC/GS receiver	2	42	
VHF navigation communication control	2	4	
VOR localizer antenna	2	44	
Glide slope antenna	1	5	
Coax (450 ft)		54	
Distance Measuring Equipment (DME)			82.2
Transmitter-receiver	2	74	
Flush antenna	1	1.5	
Coax (56 ft)		6.7	
Marker Beacon			9.2
Receiver	1	2	
Antenna	1	4	
Coax (27 ft)		3.2	

	Quantity		Weight (lb)
Flight Data Recorder			23
Recorder unit	1	20	
Trip data recorder	1	2	
Normal accelerometer	1	1	
Flight Deck Voice Recorder			19.0
Voice recording unit	1	17	
Control panel	1	1	
Monitor box	1	1	
Nose Radome	1		250
Cooling Provisions			69
Lining			47
Rack			241
Wiring and Interface Boxes			300
Wire Supports and Connectors			50

7.17.2 Weight Determination Methods and Design Data. The weight of a majority of the electronic components is based on equipment which reflects additional solid-state and miniaturization developments.

Systems data from Collins, Honeywell, Telephonics, Sperry, Bendix, Gables, and other sources were used for much of the weight data.

The weights of cooling provisions, wire, and interface boxes are estimated from drawings and other design data. The radome unit weight is based on a test model and is estimated to be 0.141 lb/cu in. Hinge and latch weight is estimated to be approximately 8 percent of the total weight.

7.18 Furnishings. Furnishings include four categories of interior finish and equipment: flight provisions, passenger accommodations, cargo handling, and emergency equipment. See Systems Report, V2-B2707-11.

Flight provisions consist of control cab equipment and other components required to provide convenience, comfort, and safety for the flight crew.

Passenger accommodation weights are shown for the 277 passenger International Mixed configuration, 30 first class and 247 tourist class passengers.

Significant weight reductions are realized through the use of lightweight, self-extinguishing, plastic materials for the cabin interior and furnishings.

Passenger seat weights are 22 lb per seat bottom in the first class section and 18 lb per seat bottom in the tourist section including integral trays. An outstanding seat design that saves weight, both in seat structure and upholstery, is well along in its development stages. Appearance and comfort levels are comparable to present passenger airplane seats.

Cargo compartments provide improved serviceability and are adaptable to containerized cargo at the option of the operator.

7.18.1 Detail Weights.

	Quantity	Weight (lb)		
Furnishings				
Total				13,300
Flight Provisions			530	
Pilot seat (including harness)	1	52		
Copilot seat (including harness)	1	52		
Engineer seat (including harness)	1	48		
Observer seat (including harness)	2	48		
Engineer work table	1	12		
Pilot control stand	1	80		
Instrument panels		60		
Refueling station control panel	1	2		
Lining and lining attachments		85		
Floor covering		7		
Rain removal system		63		
Sun visors	2	3		
Blackout curtains		3		
Waste container holder	2	1		
Flight kit holders	3	2		
Mirror	1	1		
Emergency equipment shelf	1	3		
Crew coat rack	1	1		
Locker	1	5		
Flight manual	1	2		
Passenger Accommodations			11,320	
Seats, passenger first class	15	660		
Seats, passenger tourist, triple	81	4,374		
Seats, passenger tourist, double	2	72		
Seats, attendant double	5	120		
Passenger safety belts	277	194		
Attendant safety belts and harness		10		
Attendant panels	4	12		
Utility rack		734		
Passenger service unit	98	216		
Window dust cover and reveal	152	100		
Signs and interior markings		25		
Coat compartments	1	40		
Floor covering		1,020		
Lining and lining attachment		840		
Baseboard and air grills		160		
Light covers		305		
Partition, Station 755		50		
Washing and drinking water facilities		220		
Lavatories and lavatory partitions	6	960		
Class divider	1	15		
Wind screens	6	70		

	Quantity	Weight (lb)	
Ceiling		580	
Utility panels		225	
Life raft tiedowns	12	23	
Escape chute provisions	8	160	
Stowage compartments	1	25	
Magazine racks	4	10	
Galley tiedowns	5	100	
Cargo Handling			1,110
Lining and lining attachment		900	
Stanchions		60	
Cargo nets		100	
Cargo tiedowns		50	
Emergency Provisions			340
Oxygen system, crew only		110	
Hand fire extinguishers provisions	7	10	
Hand fire extinguishers	7	50	
Fire detection		24	
Nacelle fire extinguishing system		96	
Fire axe provisions	2	2	
Escape ropes	6	36	
First aid kits and provisions	2	12	

7.18.2 Weight Determination Methods and Design Data. Flight provisions and emergency accommodations weights are based on current aircraft equipment.

Passenger accommodations items, cargo compartment lining, and cargo restraint items are estimated from drawings. Unit weight of lining includes a 30-percent factor for fastening, trim, and mullions

Emergency provisions are based on current aircraft equipment.

Interior Standards

	Quantity	Unit Weights
Number of lavatories	6	160 lb
Length of utility racks	306 ft	2.4 lb/ft
Floor carpet and pad area	231 sq yd	55 oz/sq yd
Sidewall carpet area	37 sq yd	47 oz/sq yd
Galley mat area	6.8 sq yd	50 oz/sq yd
Entry mat area	10.9 sq yd	50 oz/sq yd
Cabin lining area	1,811 sq ft	0.46 lb/sq ft
Ceiling panel area	1,446 sq ft	0.40 lb/sq ft
Utility panels	614 sq ft	0.36 lb/sq ft
First Class double seat (includes integral trays)	15	44 lb
Tourist double seat (including integral trays)	2	36 lb

	Quantity	Unit Weights
Tourist triple seat (including integral trays)	81	54 lb
Passenger seat belts (first class and tourist)	277	0.7 lb

Design Criterion. Passenger and Cargo Accommodations Subsystem Specification, D6A10110-1.

7.19 Air Conditioning. The air-conditioning system is described in Systems Report, V2-B2707-10.

The principal features of this system are:

a. Four cooling units located in the horizontal stabilizer supplying cooling air to separately controlled zones

b. Cabin intrawall cooling system

c. Electrical cabin pressure control system

d. Overhead air supply system

e. Turbofan in air coolant system for ground operation

7.19.1 Detail Weights.

	Quantity	Weight (lb)		
Air Conditioning				
Total				5,500
Components Items			2,311	
Compressor, engine-driven	4	470		
Heat exchangers				
Primary air to air	4	400		
Secondary air to air	4	224		
Regenerative air to air	4	320		
Primary air to fuel	4	128		
Secondary air to fuel	4	128		
Air cycle machine	4	84		
Moisture separator	4	52		
Ground coolant turbofan	4	168		
Ambient air scoop	4	50		
Thrust recovery nozzle	4	5		
Engine bleed air duct	4	52		
Valves				
Check		95		
Shutoff		50		
Control		85		

	Quantity	Weight (lb)
Component Systems, Cabin		138
Pressure control system	66	
Temperature control system	52	
Ozone detection system	20	
Heat Exchanger Fluids		16
Equipment Supports		440
Wiring		240
Duct Installations		2,355
Horizontal Tail	760	
Passenger cabin	1,520	
Flight deck	75	

7.19.2 Weight Determination Methods and Design Data. The major component items of the system are described in AiResearch Proposal 66-0617, Vol. II, June 6, 1966 and Hamilton Standard Proposal EP66335, Vol. II, Book 1, June 20, 1966.

The weights shown in these proposals are ratioed to reflect the required size units. The engine bleed air manifold, system ducting, and equipment support weights are estimated from layouts and diagrams.

General system requirement	Dispatch with one pack inoperative
Alternate air source	Engine bleed air
Cabin altitude	6000 ft at airplane altitude of 70,000 ft (11.12 psi differential pressure)
Cabin temperature	75°F (Dry bulb during cruise)
Temperature zones	4 (Independently controlled)
Ventilation rate (fresh air)	20 cfm/passenger and crew member up to and including normal cruise altitude 97 lb/min per unit at cruise condition
Heat exchanger buffer zone Fluid, water/glycol	8.0 lb/gal
System diagram	See Systems Report, V2-B2707-10, Fig. 1-1

7.20 Anti-Icing and Antifogging. Each engine installation is equipped with independent anti-icing for the air induction system. Ports, ducts, valves, and shields provide distribution of high-spool bleed air as required for the following:

a. Inlet nose cone

b. Inlet struts

c. Air data sensors

d. Inlet cowl perimeter

The bleed-air source is at the forward end of the engine manufacturer's anti-icing area on the General Electric engine.

Pratt and Whitney engines do not require anti-icing. Therefore, the high-spool bleed air for the inlet must be ducted from a port near the aft end of the engine. A control valve and thermal switch must be installed by the airframe manufacturer. See Systems Report, V2-B2707-10 and Propulsion Report, V2-B2707-12.

The windshield anti-icing and antifogging provisions are electrical.

Air data sensor ice protection consists of an electrical heating element which is a part of the sensor unit. The weight is therefore distributed to the instrument group.

7.20.1 Detail Weights.

	Quantity	Weight (lb) GE			Weight (lb) P&WA		
Anti-Icing and Antifogging							
Total				280			330
Engine Inlet Anti-Icing			233			283	
Valves		7			28		
Ducts, supply		77			84		
Anti-icing and spray duct		68			73		
Joints and supports		24			28		
Inner skin, baffle, attachments, and supports		47			50		
Wire and associated circuitry		10			20		
Windshield Anti-Icing and Antifogging			30				
Temperature controllers		12					
Window heating system		2					
Sensors and supports		2					
Wire and associated circuitry		14					
Air Data Sensor Anti-Icing Heater (Air data pitot is a part of instruments)			17				
Wire and associated circuitry		17					

7.20.2 Weight Determination Methods and Design Data. The weights of the bleed air control and distribution system are estimated from layouts.

The weights of windshield ice and fog protection are estimated from known systems.

Adverse weather system control panel	Diagram document V2-B2707-10, Fig. 1-15
Windshield anti-icing and antifogging	Diagram document V2-B2707-10, Fig. 1-16
Engine inlet anti-icing	Subsystem Spec. D6A10117-1, Fig. 6-2

7.21 Insulation. Material with density range and mass requirements to meet acoustical needs is installed to comply with thermal requirements. When acoustical requirements are greater than those for thermal control, special acoustical insulation is installed.

Aft location of the engines minimizes the need for special acoustical insulation. See Internal Noise Program, V4-B2707-5, for acoustical data and Systems Report, V2-B2707-10 for thermal data.

7.21.1 Detail Weights.

	Weight (lb)	
Insulation		
Total		2,700
Control cabin	77	
Electronics compartment, forward	43	
Electronics compartment, aft	17	
Electrical and air-conditioning distribution bay	40	
Passenger cabin	1,295	
Forward cargo compartment	279	
Aft cargo compartment	139	
Lower lobe, forward	85	
Floor	149	
Main wheel wells, strake	200	
Main wheel wells, body	15	
Nose wheel well	5	
Air-conditioning cooling unit bay, top and bottom	23	
Air-conditioning cooling unit bay, sidewall	12	
ADS bay, strake	7	
ADS bay, body	5	
Hydraulic equipment bay	6	
Aft bulkhead	55	
Upper lobe Station 2834-3034	135	
Air-conditioning riser ducts	113	

7.21.2 Weight Determination Methods and Design Data. Areas are developed by reference to configuration drawings. Aluminum vapor cloth facing is used on the insulation which results in an overall lightweight batt. (See Table 7-E)

7.22 Ballast System. A tank containing nonexpendable water is utilized to maintain the airplane center of gravity within flight limits for ferry flights and extremely low payloads. See Systems Report, V2-B2707-11. The tank is located in the lower lobe of the body between stations 750 and 965 and consists of bladder-type cells which have a maximum capacity of 11,500 lb. A special filler receptacle is designed to prevent inadvertent filling with any other fluid. The design is such that filling or draining the system can be accomplished simultaneously with normal service operations.

Table 7-E. Insulation Description

	Inbd and Outbd Face	Core			Unit Weight
Location	Material	Material	Density	Thickness, In.	lb/sq ft
Control cabin	1	Fiberglass	1 pcf	3.0	0.328
Electronics compartment--forward			1 pcf	3.0	0.328
Electronics compartment--aft			1 pcf	3.0	0.328
Electrical bay			1 pcf	3.0	0.328
Passenger cabin			1 pcf	3.0	0.328
Forward cargo			1 pcf	3.0	0.328
Aft cargo			1 pcf	3.0	0.328
Lower lobe — forward of Nose wheel well			0.6 pcf	3.0	0.218
Floor			0.6 pcf	0.5	0.075
Floor			0.6 pcf	1.5	0.132
Main wheel wells — strake			3.0 pcf	1.0	0.323
Main wheel wells — strake			0.6 pcf	1.0	0.103
Main wheel wells — body			0.6 pcf	1.0	0.103
Nose wheel well			0.6 pcf	1.0	0.103
Air-conditioning cooling units — top and bottom			0.6 pcf	0.5	0.075
— sidewall			0.6 pcf	0.5	0.075
Air-conditioning distribution bay			1 pcf	3.0	0.328
ADS bay — strake			0.6 pcf	0.5	0.075
ADS bay — body			0.6 pcf	0.5	0.075
Hydraulic equipment bay			0.6 pcf	0.5	0.075
Aft bulkhead —	1	Fiberglass	1 pcf	3.0	0.328
—					0.458
Upper lobe — special acoustical treatment					
Sta 2834-3034	2				0.458
Aft bulkhead	2				0.312
Air-conditioning riser ducts	3		702 pcf	0.009	0.527

1 Silicone rubberized glass fabric with vapor deposited aluminum. Septum is 2.5 oz/sq yd.

2 Lead Vinyl Cloth

3 Lead Sheet 702 pcf

Note Fastener allowance included in the unit weight.

Acoustical insulation — Maximum sound levels are established from data in Boeing document D6-17656TN, April 28, 1965.

Thermal insulation requirements — See Systems Report V2-B2707-10, Par. 1.2.1.10.

Internal noise program — See Internal Noise Program, V4-B2707-5.

7.22.1 Detail Weights.

			Weight (lb)
Ballast System			
Total			150
Bladder Cells		44	
Fittings		13	
Vents and interconnects	3		
Access fittings	10		
Interconnects		23	
Vents and interconnects	10		
Access doors	13		
Supports and Laces		8	
Backing Board		62	

7.22.2 Weight Determination Methods and Design Data. Ballast system weights are based on drawings of current bladder cell and interconnect designs.

7.23 Standard and Operational Items. The standard and operational items are the items required to define the increment between the manufacturer's empty weight and the operational empty weight.

7.23.1 Detail Weights.

	Quantity	Weight (lb)		
Standard Items				
Total				4,165
Unusuable fuel			1,192	
Unusuable oil			252	
Emergency equipment			512	
Oxygen equipment, portable	40	40		
Fire axes	2	6		
Escape slides	8	466		
Unusable water, wash and drink		10		
Toilet water and chemical		150		
Galley structure (see Table 7-F)	5	2,049		
Operational Items				
Total			6,585	
Crew and Crew Baggage			1,850	
Flight crew	3	510		
Cabin crew	8	1,040		
Crew baggage	11	275		
Captain's briefcase	1	25		
Usable Oil		80		
Emergency Equipment			1,975	
Liferafts, 25 man	12	1,500		
Emergency transmitters	4	20		
Life vests	303	455		

	Quantity	Weight (lb)
Usable Water, wash and drink		384
Passenger Service Equipment (See Table 7-F)	277	720
Food and Beverages 1.5/lb passenger	288	432
Galley Service Equipment (See Table 7-F)	288	639
Liquor Service (See Table 7-F)	277	393
Lavatory Supplies (See Table 7-F)	6	57
Plug-In Food Trays	22	55

7.23.2 Weight Determination and Design Data.

a. The unusable fuel weight estimate is based on the B-2707 fuel system described in Propulsion Report, V2-B2707-13, Sec. 2.0.

b. Unusable oil includes estimated quantities of engine lubrication oil, engine manufacturers' hydraulic system oil, accessory drive system lubricating oil, generator lubricating/cooling oil, and air-conditioning compressor lubricating oil.

c. The emergency equipment includes 40 small portable oxygen bottles (refer to Scott Aviation Corporation Proposal 66-367, July 20, 1966.) Escape slide weights are determined by using supplier data with allowances for advanced state of the art. The fire axe unit weight conforms with Table II of FAA document SST 65-13, Weight and Balance Standard.

d. The unusable water weight is based on a single-tank system.

e. The toilet chemical and water weight is based on six toilets per airplane.

f. A coordinated design study between the airframe manufacturer and a leading galley manufacturer is the basis for the weight estimates.

g. There are three flight crew and eight cabin attendants.

h. The usable oil is based on 1/2 gal/engine/hr for 10 hr.

i. Life vests and liferafts conform to Table II of FAA document SST 65-13, Weight and Balance Standard. Quantities are for 277 passengers and 11 crewmembers. A 5-percent allowance is included for spare life vests. The emergency transmitter weight is a Garrett Mfg. Ltd. quotation.

j. Usable water is 0.0535 gal/person/flight hr. Both passengers and crew are included in the total water computation. The standard considered for flight time is 3 hr.

k. Food and beverage allowance is 1.5 lb per passenger

l. Plug-in food trays are used when integral seat trays are not available.

Table 7-F. Passenger Service Equipment Weight

	First Class Galley Weight (lb) (40-Meal Unit)	Tourist Galley Weight (lb) (60-Meal Unit)
Structure	155	232
Refrigerator	27	27
Oven	47	70
Tray Carrier	47	70
Waste Container	8	8
Total Basic Structure	284	407
Basic Structure	284	(4) 1,628
Serving Cart	20	(3) 60
Coffee Maker	19	(2) 38
	323	1,726

Item	Unit Weight (lb)
Blankets	1.00
Pillows	0.70
Head Rest Covers	0.10
Magazines	0.55
Passenger Service Kit	0.21
Air Sickness Container	0.04
	2.60
277 Passengers, 2.6 Lb/Passenger	= 720

Galley Service Equipment

Item	Unit Weight (lb)
Tray	0.72
Casserole Dish	0.33
Salad Plate	0.17
Dessert Dish	0.17
Bread and Butter Plate	0.17
Coffee Cup	0.13
Silver Ware Set	0.38
Condiment	0.15
	2.22
277 Passengers and 11 Crew, 2.22 lb/passenger	= 639

Liquor Service

Recent review of airline data

Item	Unit Weight (lb)
Glasses	0.43
Miniatures (2)*	0.39
Mixer	0.40
Ice	0.20
	1.42
277 Passengers x 1.42 lb	= 393

*FAA limits two to a passenger

Lavatory Supplies

Tourist	9 lb/lavatory
First Class	12 ib/lavatory

8.0 ABBREVIATIONS AND UNITS OF WEIGHTS AND MEASURES

The following units are used throughout this document, unless otherwise noted:

Dimensions	Units
Linear	Inches, feet, nautical miles
Area	Square inches, square feet
Volume	Cubic inches, cubic feet
Liquid measure	U.S. gallons
Weight	Pounds

The following abbreviations are used in this document unless otherwise noted:

ADF	Automatic direction finder
ADS	Accessory drive system
ATC	Air Traffic Control
BL	Buttock Line
BMS	Boeing Material Specification
B.S.	Body station
c_R	Length of wing reference chord
EGT	Exhaust gas temperature
GS	Glide slope
H.F.	High frequency
I	Moment of inertia
kva	Kilovolt amperes
kw	Kilowatt
n	Limit load factor
O.E.W.	Operational empty weight
Q or q	Dynamic pressure
RAT	Ram air turbine
SAS	Stability augmentation system
t/c	thickness to chord ratio
VHF	Very high frequency
VOR	Visual omnirange
WBL	Wing buttock line
WL	Waterline
Λ	Leading edge sweep angle
VS CF	Variable speed-constant frequency

SUPPLEMENT A

PROTOTYPE AIRPLANE SUMMARY

This supplement gives the design weights, a modified group weight statement, and airframe weight for the prototype airplane.

The prototype airplane has a gross weight of 635,000 lbs compared with the production airplane of 675,000 lb. The 635,000-lb weight was also used as the design point for the production airplane weight analysis with growth to 675,000 lb. The only differences in the manufacturer's empty weight of the design point airplane and the prototype airplane are the following:

a. Flight crew emergency exits

b. Flight test access doors

c. Reduced passenger seating from 277 to 54

d. Substitution of material and equipment and fabrication modifications to facilitate prototype construction.

1. DESIGN WEIGHTS

Prototype Airplane Design Weights Summary

	GE	P&WA
Maximum Design Taxi Weight	635,000	635,000
Maximum Design Takeoff Weight, flaps down	632,500	632,500
Maximum Design Flight Weight, flaps down	628,000	628,000
Maximum Design Flight Weight, flaps up n = 2.5	627,000	627,000
Maximum Design Landing Weight	425,000	415,000
Maximum Zero Fuel Weight	358,500	356,000
Minimum Flying Weight	310,000	306,000
Operational Empty Weight	291,400	288,900
Manufacturer's Empty Weight	285,250	282,750

2. WEIGHT STATEMENT

	GE	P&WA
Manufactuer's Empty Weight (635,00 lb gross weight design point 277 passenger airplane)	272,750	270,250
Addition of flight crew escape provisions and flight test access doors	+500	+500

		GE		P&WA
Reduce passenger seats from 277 to 54		-4,170		-4,170
Prototype construction weight increment*		+16,170		+16,170
Manufactuer's Empty Weight (635,000 lb gross weight, 54-passenger prototype airplane)		285,250		282,750
Unusable fuel	1,192		1,192	
Unusable oil	252		252	
Emergency equipment	512		512	
Unusable water, wash and drink	10		10	
Toilet water and chemical	150		150	
Galley structure	2,049		2,049	
Total Standard Items		4,165		4,165
Basic Empty Weight		289,415		286,915
Crew and crew baggage	920		920	
Usable oil	80		80	
Emergency equipment	474		474	
Usable water, wash and drink	80		80	
Passenger service equipment	140		140	
Food and beverage	88		88	
Galley service	131		131	
Liquor service	---		---	
Lavatory service	57		57	
Plug-in-type food trays	15		15	
Total Operational Items		1,985		1,985
Operational Empty Weight		291,400		288,900

*Approximately 6 percent of Manufacturer's Empty Weight

3. AIRFRAME WEIGHT AND MATERIALS BREAKDOWN

The airframe weight for the prototype B-2707 is derived as follows:

		GE		P&WA
Manufacturer's Empty Weight		285,250		282,750
Delete	-62,250		-59,550	
Wheels, brakes, tires, and air		-8,830		-8,830
Engines-as supplied by the manufacturer		-47,200		-44,500
Accessory gear box drive		-600		-600
Engine starters		-220		-220

	GE	P&WA
Fuel bladder cells	-340	-340
Instruments, indicators, transmitters, and amplifiers	-570	-570
Electrical, power supply conversion equipment and batteries	-1,170	-1,170
Electronic, Electronic Sets Less Wiring, Connectors, Racks, and Radome	-1,210	-1,210
Air Conditioning, Pressurization, Cooling, Heat Exchanger Units, and Fluid	-2,110	-2,110
Airframe Weight	223,000	223,200

The airframe weight is made up of the following materials:

		GE		P&WA
Structure	178,400		179,100	
Titanium		137,040		137,560
Aluminum		2,230		2,230
Steel		18,290		18,390
Fiberglass		6,170		6,170
Glass		890		890
Fluid		930		955
Miscellaneous*		12,850		12,905
Non Structure	44,600		44,100	
Total Airframe Weight	223,000		223,200	

*Miscellaneous includes such items as seals, fasteners, actuators, controls, hydraulics, etc.

SUPPLEMENT B

DOMESTIC AIRPLANE SUMMARY

This supplement gives the design weights and a modified group weight statement for the 261-passenger Domestic Mixed airplane.

The domestic airplane has a gross weight of 575,000 lb compared with the production intercontinental airplane of 675,000 lbs and the design point of 635,000 lb. The Manufacturer's Empty Weight of the domestic airplane is derived empirically from the 635,000-lb design point, with additional weight changes for interior modifications. Structural changes consist of reduced gages and section areas to conform with reduced loads resulting from lower gross weight. There are additional weight reductions in systems and equipment weight. The domestic airplane interior has 261 passengers with 50 first class and 211 tourists as compared with the 277 passenger International Mixed configuration. (See Systems Report, V2-B2707-11, Sec. 7.)

1. DESIGN WEIGHTS

Domestic Airplane Design Weights Summary

	GE	P&WA
Maximum Design Taxi Weight	575,000	575,000
Maximum Design Takeoff Weight, flaps down	572,500	572,500
Maximum Design Flight Weight, flaps down	570,000	570,000
Maximum Design Flight Weight, flaps up n = 2.5	569,000	569,000
Maximum Design Landing Weight	410,000	400,000
Maximum Zero Fuel Weight	350,500	348,000
Minimum Flying Weight	301,000	297,000
Operational Empty Weight	275,500	273,000
Manufacturer's Empty Weight	267,420	264,920

2. WEIGHT STATEMENT

	GE	P&WA
Manufacturer's Empty Weight (635,000-lb gross weight design point 277-passenger airplane)	272,750	270,250
Reduce gross weight from 635,000 lb to 575,000 lb (8% of gross weight)	-4,800	-4,800
Reduce passengers from 277 to 261 and revise interior	-530	-530
Manufacturer's Empty Weight (575,000 lb gross weight, 261-passenger domestic mixed airplane)	267,420	264,920

	GE	P&WA
Unusable Fuel	1,062	1,062
Unusable Oil	252	252
Emergency Equipment	512	512
Unusable Water, wash and drink	10	10
Toilet Water and Chemical	125	125
Galley Structure	1,642	1,642
Total Standard Items	3,603	3,603
Basic Empty Weight	271,023	268,523
Crew and Crew Baggage	1,850	1,850
Usable Oil	80	80
Usable Water, Wash and Drink	367	367
Passenger Service Equipment	679	679
Food and Beverage	408	408
Galley Service	604	604
Liquor Service	371	371
Lavatory Service	48	48
Plug-In-Type Food Trays	70	70
Total Operational Items	4,477	4,477
Operational Empty Weight	275,500	273,000

ILLUSTRATIONS

TABLES